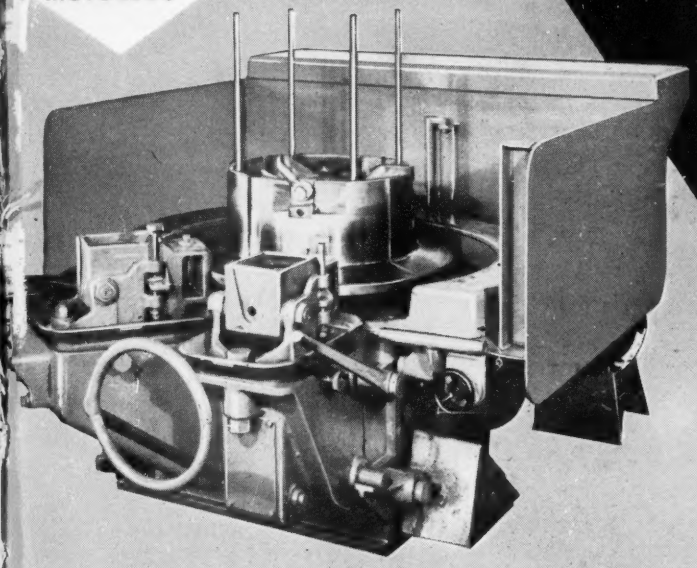
WIRE AND WIRE PRODUCTS

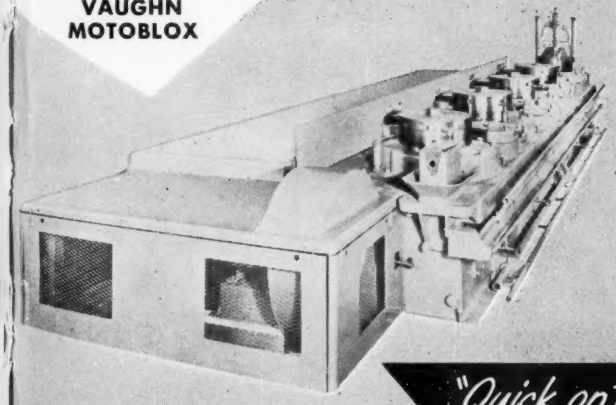
JANUARY 1950

VAUGHN MOTOBLOC



Vaughn
WIRE DRAWING MACHINERY
means
Wire
as you want it...

VAUGHN MOTOBLOX



every working day in the year!

Vaughn Motobloc and Motoblox marry flexibility with stamina—to stay productively on the job through your toughest schedules, and always be ready for more! Specify MOTOBLOC in single or double deck types—or MOTOBLOX for continuous requirements—and you get *wire production* at a sound competitive advantage. Write!

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.

"Quick on the Draw!"
VAUGHN MACHINERY
Profitably used by leading wire mills since 1871

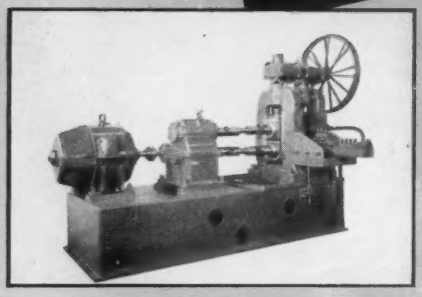
V

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole... for the Largest Bars and Tubes ... for the Smallest Wire ... Ferrous, Non-Ferrous Materials or their Alloys.

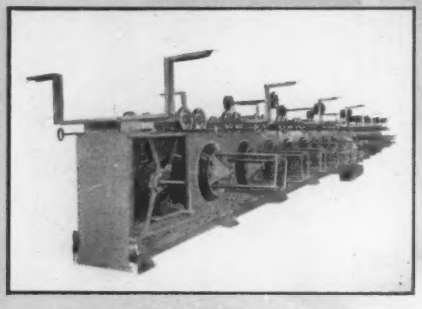
OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

LOOK TO Wean FOR WIRE MACHINERY

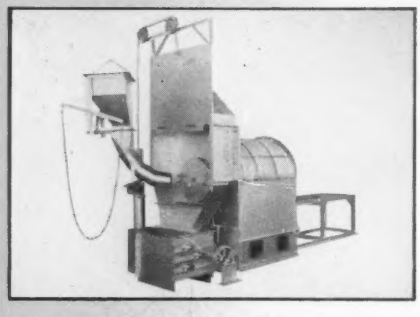
Process OR Product



2—Hi Wire Flattening Mill



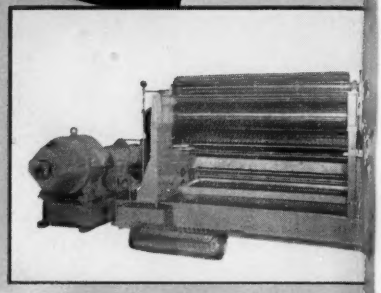
Wire Galvanizing Take-Up Frame



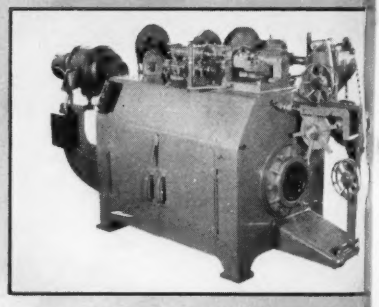
Nail Galvanizing Unit

In the past few years tremendous progress has been experienced in the field of wire machinery. Production speeds have been tripled and quadrupled. Product quality has been greatly improved. Machines have been made easier to operate and maintain.

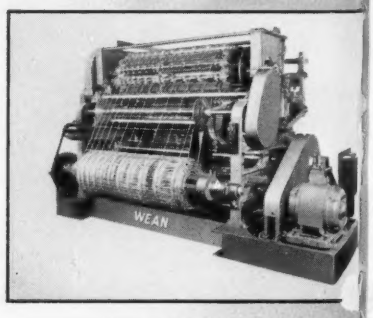
The Wean Equipment Corporation has been a large contributor to this advancement. Wean wire mill specialists have designed, built, and installed wire mill equipment for the leading wire producers the world over. If you make wire you should look to Wean for the best in machinery, service, and facilities.



Hexagon Netting Machine



2 or 4—Point Barbed Wire Machine



Hinge — Joint Fence Machine

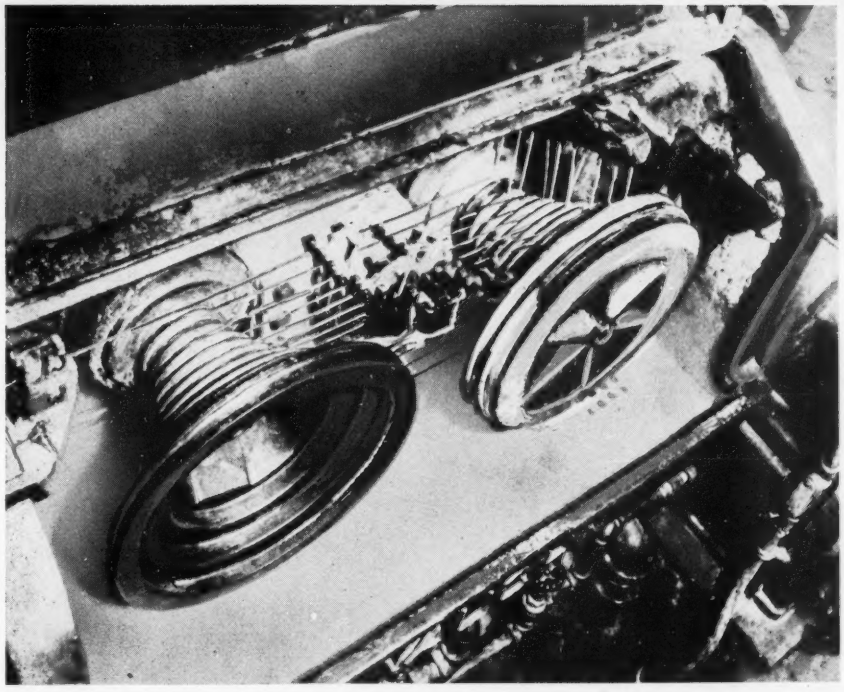
NARROW STRIP MACHINERY

(FOR 36" WIDTHS OR NARROWER)

Wean Equipment Corporation

CLEVELAND, OHIO

COMPETITIVE NON-FERROUS LUBRICANTS LAST 3 to 4 WEEKS...



APEX WD-45 LASTS SIXTEEN WEEKS!

WD-45 . . .
extremely stable
easily mixed
non-separating
minimum foam
rancid-proof
low pH

By many actual tests made in wet drawing fine copper wire and other non-ferrous metals, Apex WD-45 lasted sixteen weeks and more, an increase of 400% in operating economy!

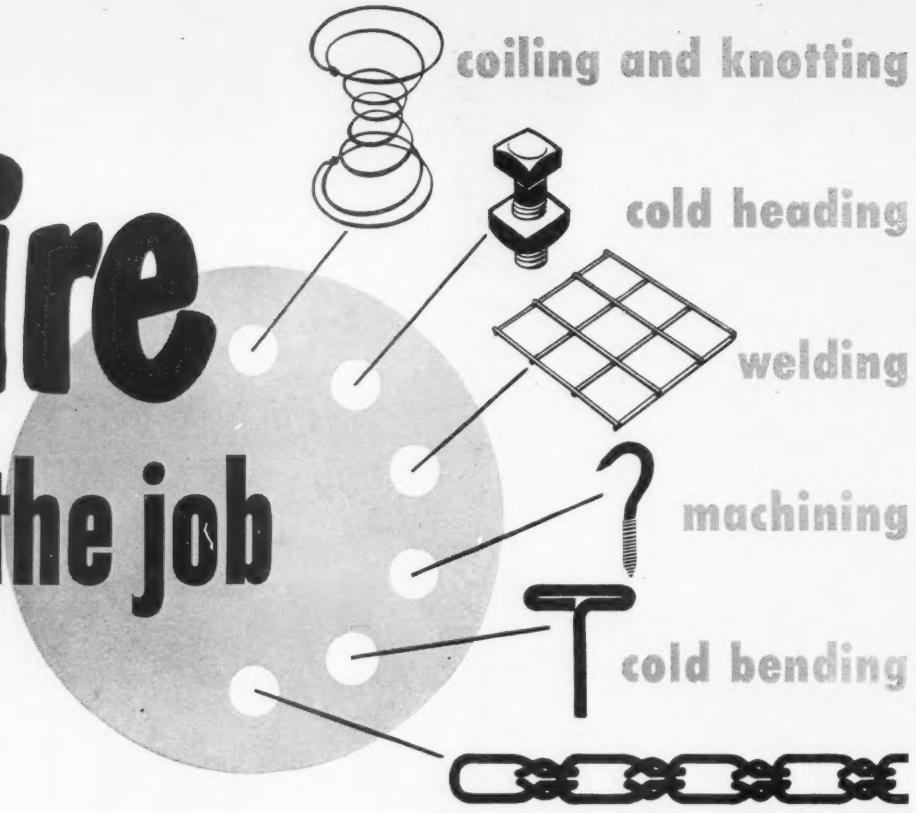
Moreover, it has given absolutely trouble-free operation, eliminating downtime. In one mill where there was a general shut-down for two weeks, the men were able to start the machinery without any trouble whatever upon their return.

We'll be glad to demonstrate WD-45 in your plant. Drop us a line.

Apex Alkali Products Co.

MAIN & RECTOR STS., PHILADELPHIA 27, PA. • PHONE: IVyridge 3-3939

Wire to do the job



Making grades of steel wire suitable for many different processing methods is a Bethlehem specialty. Whether you make kitchen gadgets, inner-spring mattresses or steel wool, our modern wire mills can turn out a top-quality wire to do the job.

One of the standard grades may suit your needs perfectly. Or your specifications may call for one of our special-purpose grades. Either way, you can count on our paying careful attention to the proper grade and quality of the steel . . . and the manufacturing procedures in our wire mills that will insure best performance of the wire for your product.

Our engineers are ready to contribute their wire-making experience to any problems you may have in the selection and processing of steel wire. Phone the nearest Bethlehem sales office . . . or drop us a line at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM WIRE

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XLN

a new magnet wire enamel

REVOLUTIONARY!

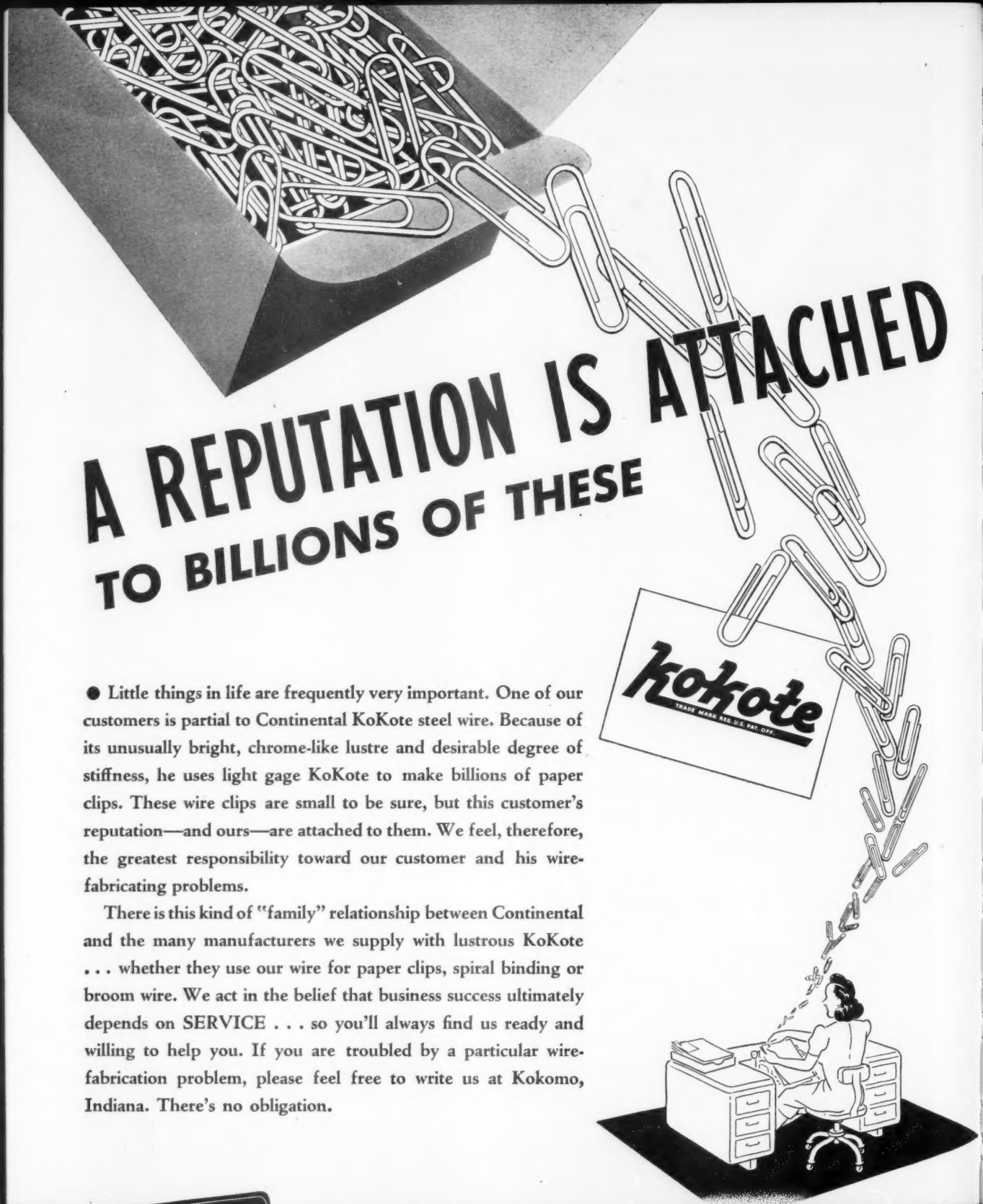
in all 3 ways

1. Needs no dies
2. Ideal for high speed application
3. Superior-by-comparison in all film characteristics

STANDARD VARNISH WORKS

ENGINEERS OF FINE FINISHES SINCE 1877

NEW YORK • LINDEN N. J. • CHICAGO



A REPUTATION IS ATTACHED TO BILLIONS OF THESE

● Little things in life are frequently very important. One of our customers is partial to Continental KoKote steel wire. Because of its unusually bright, chrome-like lustre and desirable degree of stiffness, he uses light gage KoKote to make billions of paper clips. These wire clips are small to be sure, but this customer's reputation—and ours—are attached to them. We feel, therefore, the greatest responsibility toward our customer and his wire-fabricating problems.

There is this kind of "family" relationship between Continental and the many manufacturers we supply with lustrous KoKote . . . whether they use our wire for paper clips, spiral binding or broom wire. We act in the belief that business success ultimately depends on SERVICE . . . so you'll always find us ready and willing to help you. If you are troubled by a particular wire-fabrication problem, please feel free to write us at Kokomo, Indiana. There's no obligation.

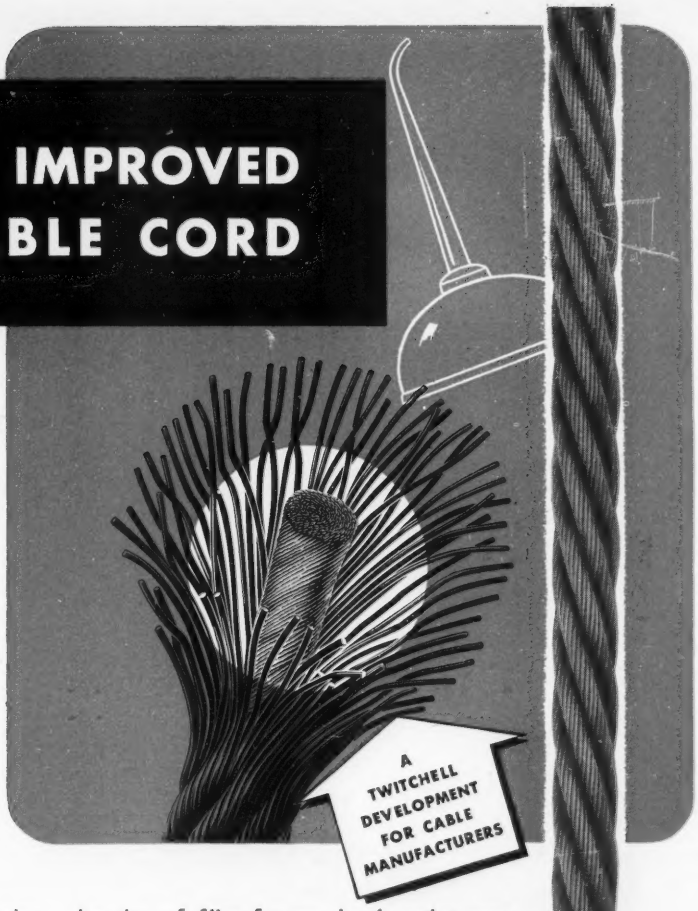
CONTINENTAL STEEL

CONTINENTAL STEEL CORPORATION

GENERAL OFFICES • KOKOMO, INDIANA

PRODUCERS OF *Manufacturer's Wire* in many sizes, shapes, tempers and finishes, including Galvanized, KOKOTE, Flame-Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright, Lead Coated, and special wire. ALSO, Coated and Uncoated Steel Sheets, Nails, Continental Chain Link Fence, and other products.

A NEW AND IMPROVED TYPE OF CABLE CORD



FOR YEARS cable makers have formed wire ropes around a center cord. This core serves as a cushion to hold the wires apart during flexing. It also serves as a reservoir for lubricants, and oils the wires every time it's squeezed.

At first these cable cords were made of imported fibres from the other side of the world. These foreign fibres came in short lengths. They were bunchy and irregular. Frequently they were scarce, and their prices skyrocketed.

Now you'll see an increasing number of steel cables with center cords made by Twitchell from American kraft fibre. The Wire Rope Corporation of America is a typical user and has been buying our fillers for years for use in automobile tow cables.

Twitchell's kraftcord cable-fillers are highly uniform in diameter. They can be supplied in "endless" lengths that make possible continuous manufacturing. For example, a popular size of filler for use in the wire rope industry is 3/16". Twitchell makes this in standard 15,000-foot endless length reels.

Twitchell wire rope cores are flexible, smooth, easy to handle. They are coated with hot wax at the Twitchell plants, arriving at your plant ready for further coating with petrolatum or other materials.

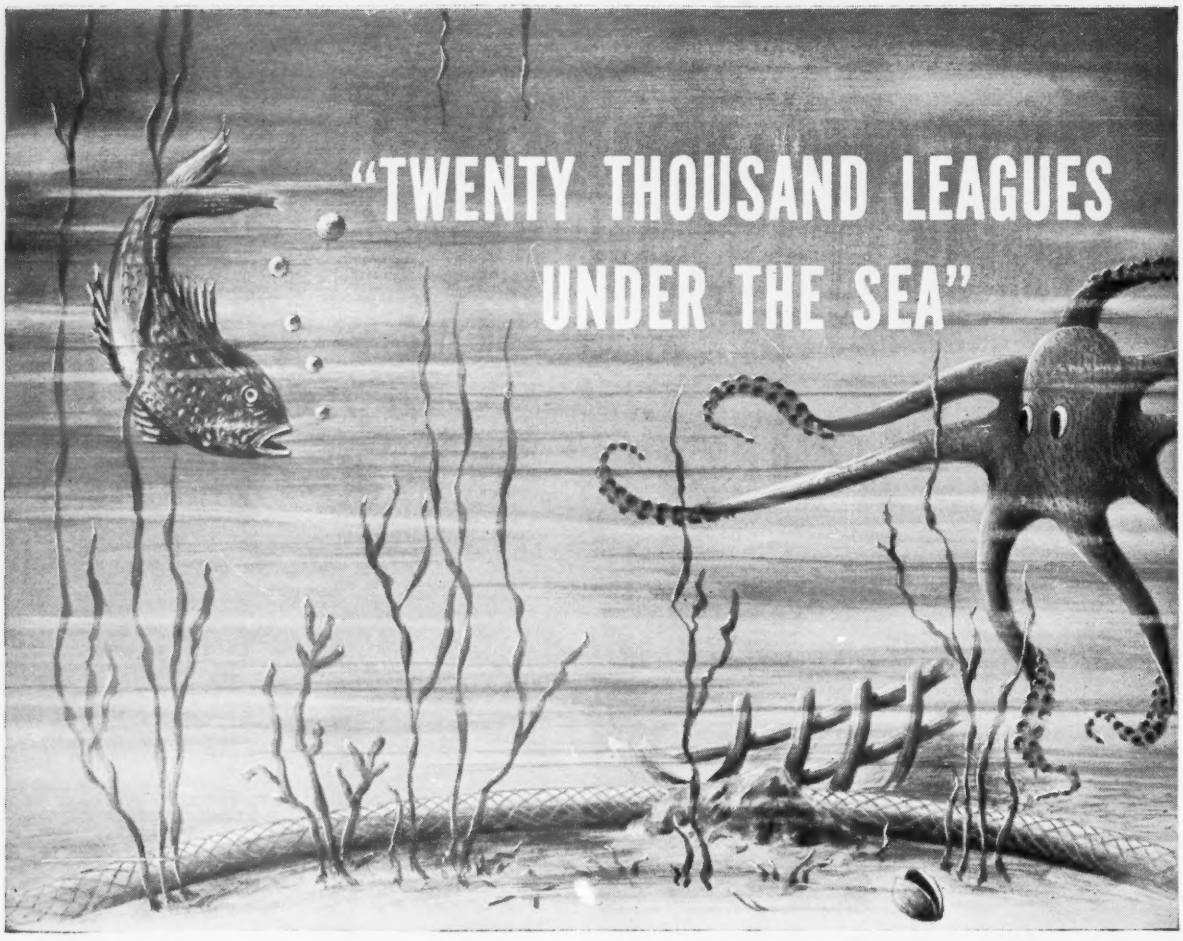
If you're looking for ways to streamline your manufacturing with uniform endless materials, let one of our men talk to you about Twitchell cores. They're made to precise standards and to your specifications. They're always available. Their prices are fair.

If you'd like the names of men you know who are using Twitchell cable cords, if you'd like to see samples and photographs of wire rope, tow cable, and other wire products built around Twitchell cords, or if you'd like samples of the cords themselves, write us or telephone us. E. W. TWITCHELL, INC., Third and Somerset Streets, Philadelphia 33, Pa.

TWITCHELL

Paper Products for the Wire Industry

TWISTED
FOLDED
PRESSED
CRUSHED
SHAPED
BRAIDED
WOVEN



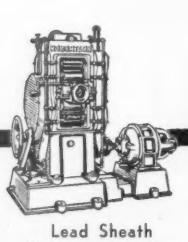
Lie great trans-oceanic cables

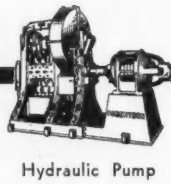
LEAD ENCASED BY ROBERTSON PRESSES . . .
Here in the mysterious depths of the ocean, these great cables are fully protected . . . because the close-fitting lead sheath formed by Robertson Cable Lead Encasing Presses is of maximum uniformity and density.

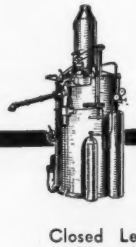
This high quality of a finished product is the direct result of Robertson craftsmen, for they are skilled specialists in the design and manufacture of fine high pressure hydraulic equipment . . . Other dependable equipment includes: hydraulic pumps, closed and open lead melting pots, lead sheath stripping machines. If you have a particular lead encasing problem, may we help you solve it?

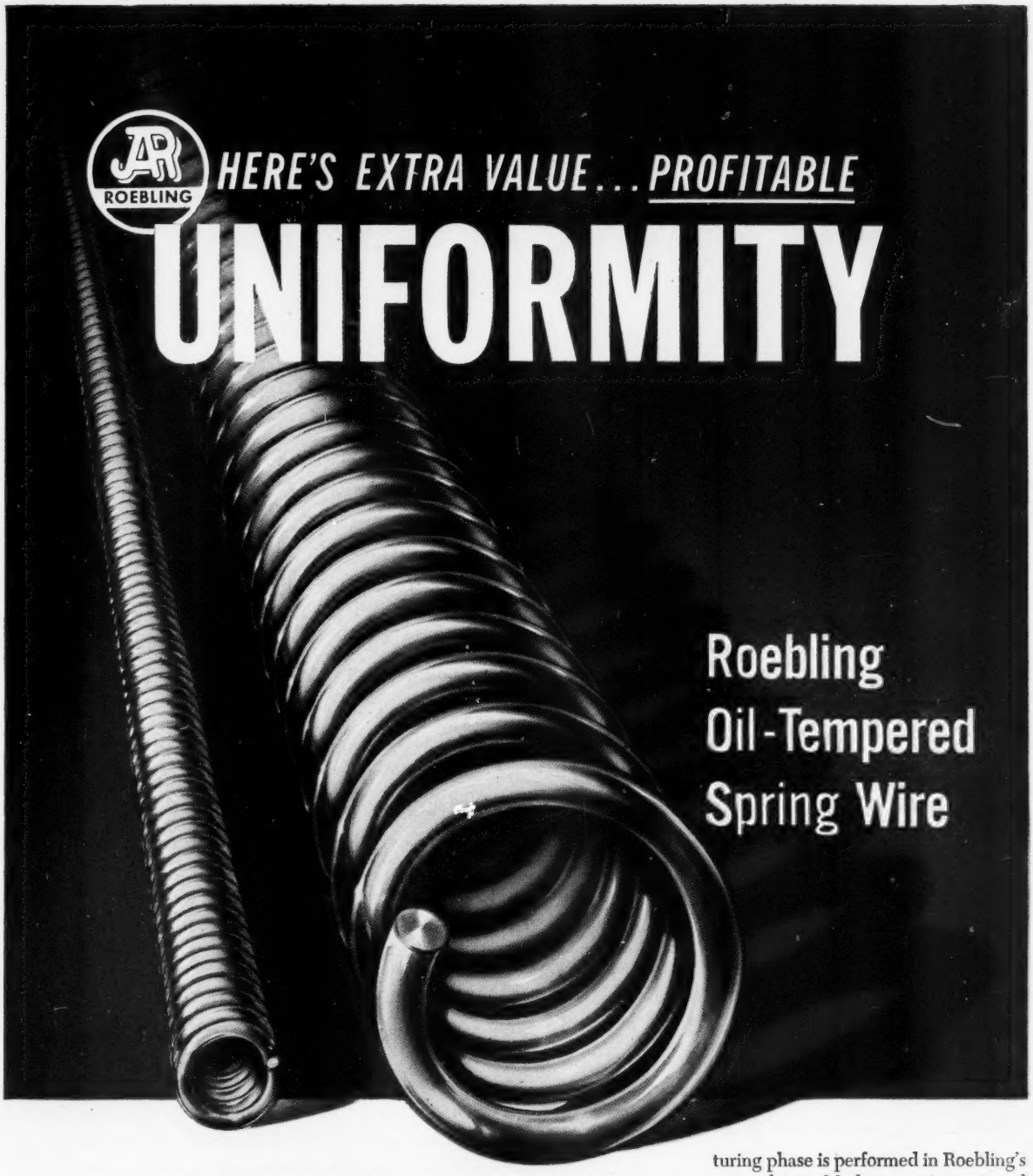
Cable Lead
Encasing Press

JOHN Robertson
COMPANY INCORPORATED
125-137 WATER STREET, BROOKLYN 1, NEW YORK
Designers and Builders of all Types of Lead Encasing Machinery
Since 1858


Lead Sheath
Stripping Machine


Hydraulic Pump


Closed Lead
Melting Pot



CUTS MACHINE STOPPAGES AND REJECTS

PRODUCTION GOES INTO HIGH with Roebling Oil-Tempered Spring Wire. Every inch is just like every other inch . . . same gauge and grain structure . . . same strength, hardness and finish. And more than that, the dependably uniform analysis of Roebling Spring Wire enables you to maintain your specified quality standards without variation.

Roebling Oil-Tempered Spring Wire, in the higher carbons, is available in all standard sizes. From making the steel to the finished product, every manufacturing phase is performed in Roebling's own plants. Modern equipment and techniques assure wire of topmost quality . . . and it's available now!

Your Roebling Field Man will be glad to help you select the right wire—round, flat or shaped—for top performance and economy in your own products. John A. Roebling's Sons Company, Trenton 2, New Jersey.

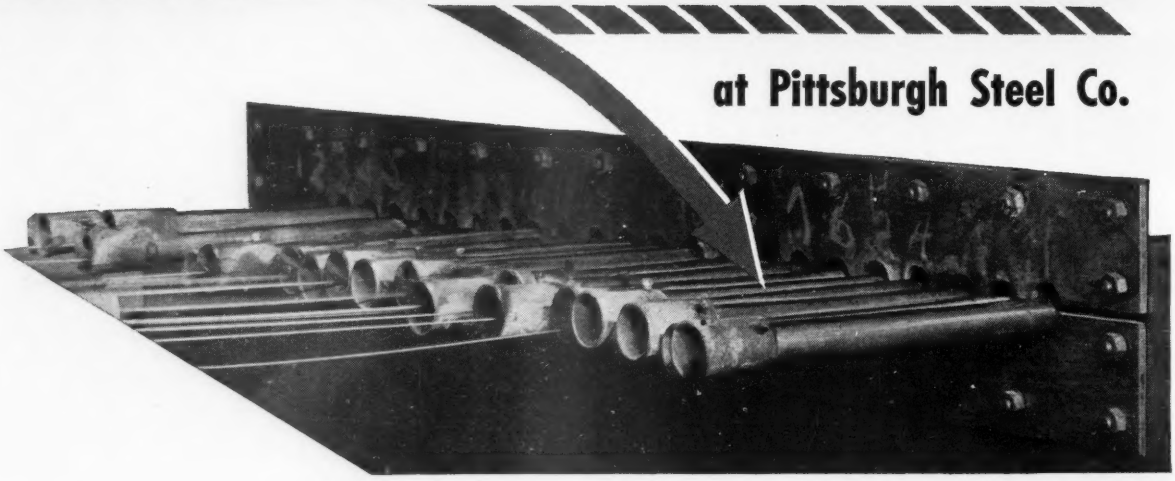
WRITE OR CALL THE ROEBLING FIELD MAN AT YOUR NEAREST ROEBLING OFFICE AND WAREHOUSE

Atlanta, 934 Avon Ave. ★ *Boston,* 51 Sleeper St. ★ *Chicago,* 5525 W. Roosevelt Rd. ★ *Cleveland,* 701 St. Clair Ave., N. E. ★ *Denver,* 1635 17th St. ★ *Houston,* 6216 Navigation Blvd. ★ *Los Angeles,* 216 S. Alameda St. ★ *New York,* 19 Rector St. ★ *Philadelphia,* 12 S. 12th St. ★ *Pittsburgh,* 855 W. North Ave. ★ *Portland, Ore.,* 1032 N. W. 14th Ave. ★ *San Francisco,* 1740 17th St. ★ *Seattle,* 900 First Ave.

ROEBLING

☆ *A CENTURY OF CONFIDENCE* ☆

INCONEL here keeps annealing costs down at Pittsburgh Steel Co.



In bright annealing furnaces of the Pittsburgh Steel Company, stainless steel wire moves continuously through a hydrogen-nitrogen atmosphere in tubes heated to 2000° F.

Pittsburgh chose INCONEL* as the metal for their furnace tubes . . . and subsequent performance records have proved the wisdom of their choice.

High temperature, corrosion-resistant, INCONEL has set endurance records in many of the nation's busiest heat-treating furnaces. For example . . . in the bright-annealing of Nickel and Monel* wire, at 1950° F., *two years' life* is reported for seamless extruded INCONEL tubing, where wire-drawing lubricants are sulphur and lead free.

In other heat-treating applications, INCONEL furnace fixtures have outlasted other quality metals with corresponding savings in maintenance and replacement costs.

If you would like to know how other plants have made considerable savings through the use of INCONEL . . . and why leading fabricators regard it as the *standard* metal for heat-treating fixtures, write for your copy of *"Keep Operating Costs Down When Temperatures Go Up."*

INCONEL SEAMLESS TUBING NOW AVAILABLE IN LARGE DIAMETERS

Seamless extruded Inconel tubing is now being produced in outside diameters of 2½" to 8½", with wall thicknesses from ¼" to ⅝". For quotations, check with your nearest INCO distributor.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

EMBLEM OF SERVICE INCO TRADE MARK

INCONEL*... for long life at high temperatures

Meet your

SWIFT SOAP TEAM

We're READY with quality soaps for every wire drawing need! You can always find the right soap for the job in Swift's complete line. Whatever your specialized need, Swift's Soap Department can fill it. And you'll find that Swift's Soaps for wire drawing uses have efficient lubrication, minimum dusting and dependable uniform quality. You can't buy finer soaps anywhere.

WILLING to help solve tough wire drawing lubrication problems!

You can put Swift's Sales Service Division to work on your soap problems today. We offer the facilities of Swift's Research Laboratories and the services of highly trained soap specialists who know your needs.

Call SWIFT first for soaps

And ABLE to give fast service from Swift distribution points coast to coast!

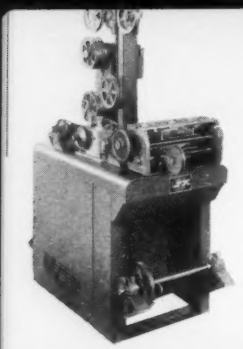
You can order any of these fine soaps and expect immediate delivery:

Powdered White Ribbon *Guaranteed Powder*

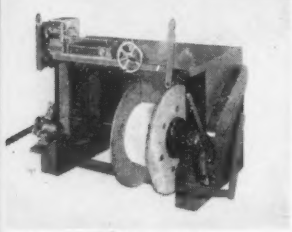
Snap Heavy Duty Wire Drawing Powder No. 282

No. 559 Powdered Soap

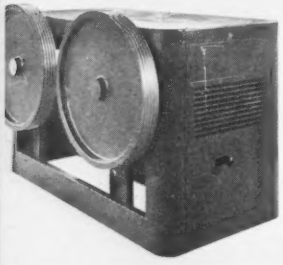
Plus other special formulations to meet your specifications. See telephone Directory for address of nearest Swift & Company Office.



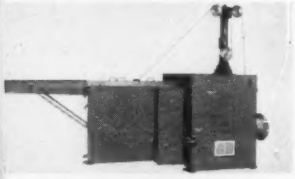
INGLE REEL TAKEUPS



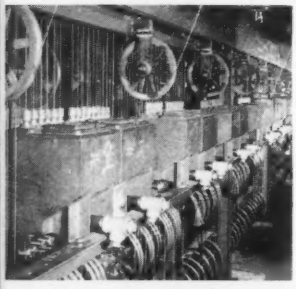
ONTINUOUS TAKEUP



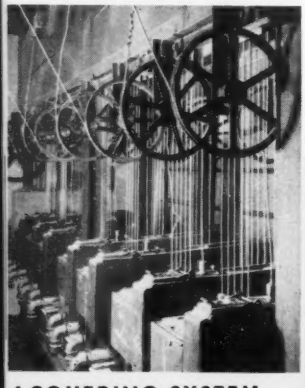
OUBLE DRUM CAPSTAN



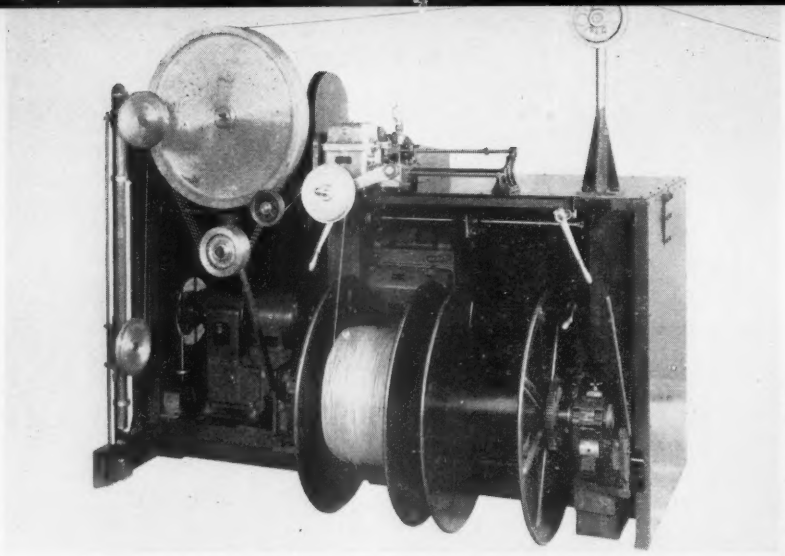
TUBING TAKEUP



ACQUERING SYSTEM



ACQUERING SYSTEM



CONTINUOUS TAKEUP WITH INTEGRAL CAPSTAN

INSULATED WIRE MACHINERY

COMPLETE EXTRUSION SYSTEMS

CONTINUOUS TAKEUPS — CORD PRE-DRYERS
LACQUERING SYSTEMS — ENAMELING MACHINES
PROCESS ANNEALERS — DRAW BENCH TAKEUPS
ASBESTOS INSULATING MACHINES
SATURATING AND FINISHING SYSTEMS

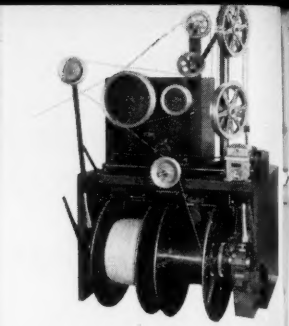
● IOI Equipment is used in the largest Wire Mills in the world. If you have a problem in this field it will pay you to consult IOI. Write for complete information.

INDUSTRIAL OVENS, INC.
13825 TRISKETT ROAD — CLEVELAND 11, OHIO
ASSOCIATED COMPANY • JAMES DAY MACHINERY LTD., LONDON, W. 1, ENGLAND

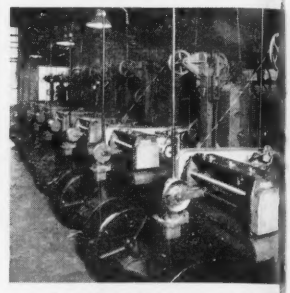
COOLING TROUGH

COOLING TROUGH

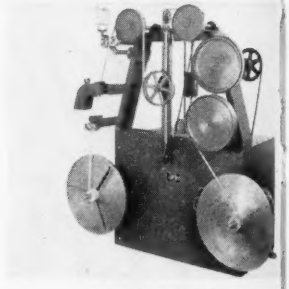
BATTERY OF 24" REEL CONSTANT TENSION TAKEUPS



DUAL REEL TAKEUP

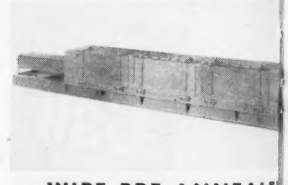


SINGLE REEL TAKEUP

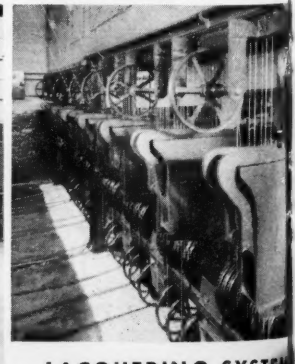


STRIP TAKEUP

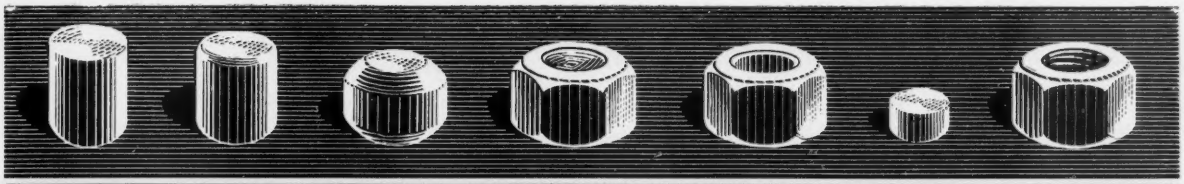
PAYOFF STANDS



WIRE PRE-ANNEALE



LACQUERING SYSTEM



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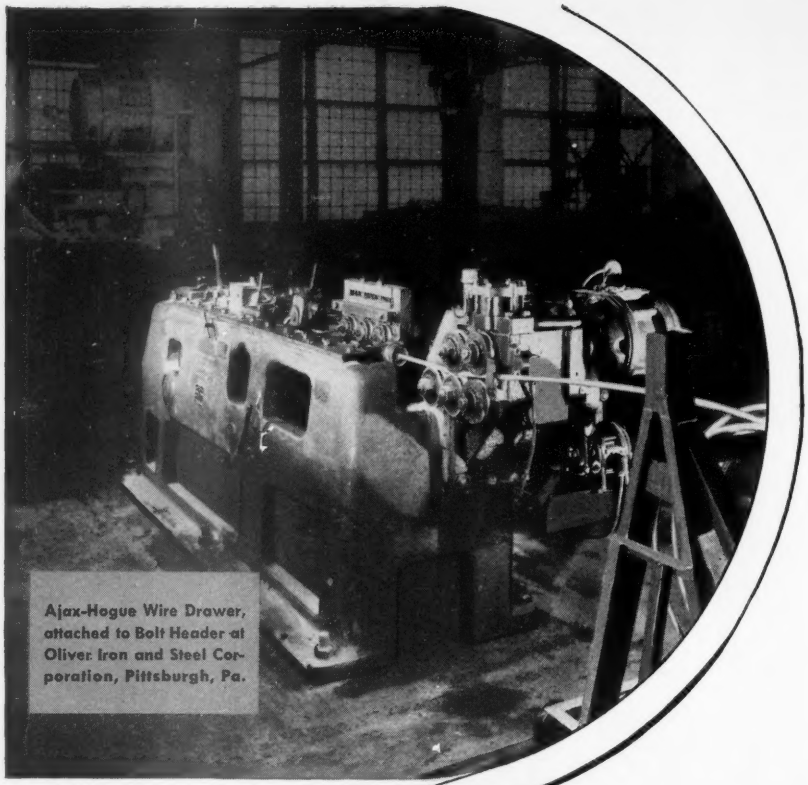
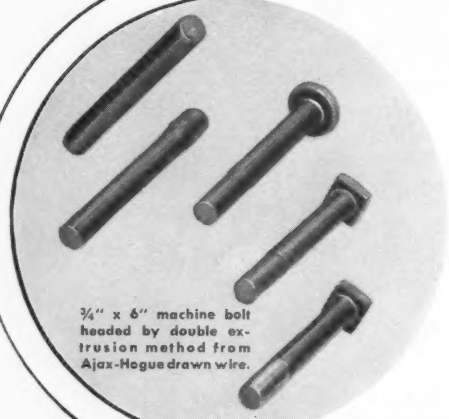


Ajax-Hogue Wire Drawer, attached to Bolt Header at Oliver Iron and Steel Corporation, Pittsburgh, Pa.

all types of cold headers should have

AJAX-HOGUE WIRE DRAWERS



¾" x 6" machine bolt headed by double extrusion method from Ajax-Hogue drawn wire.

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WRITE FOR BULLETIN No. 111.

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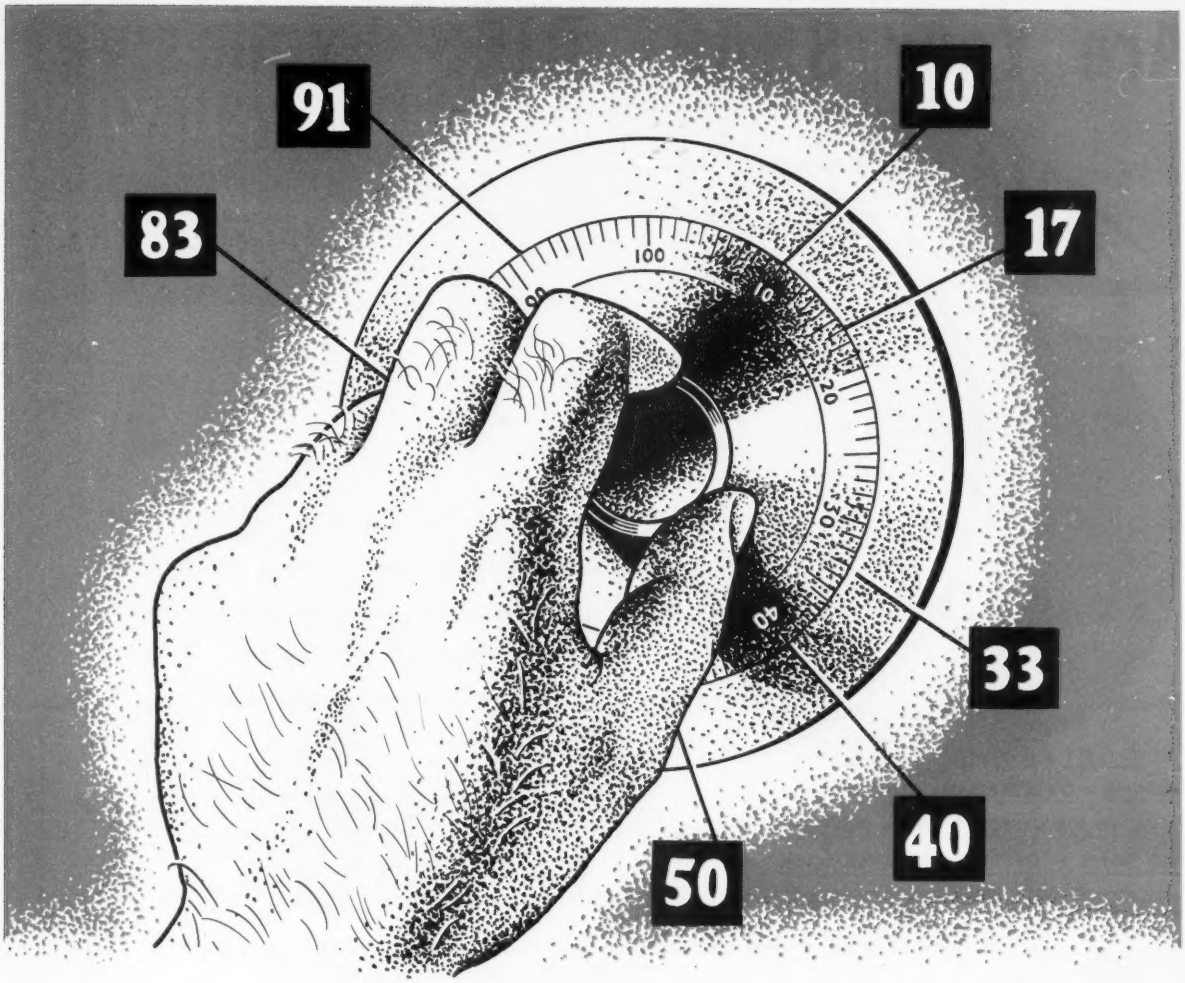

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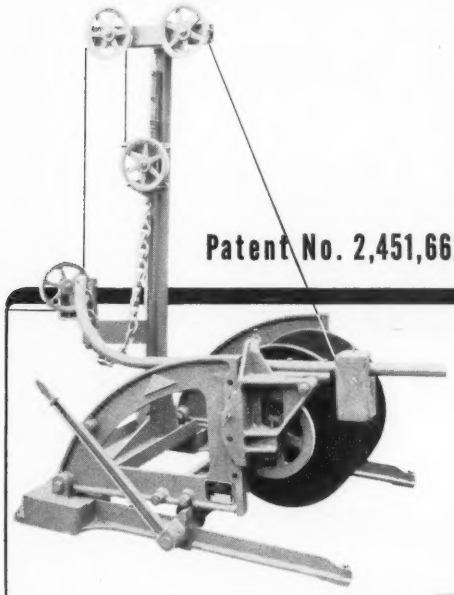

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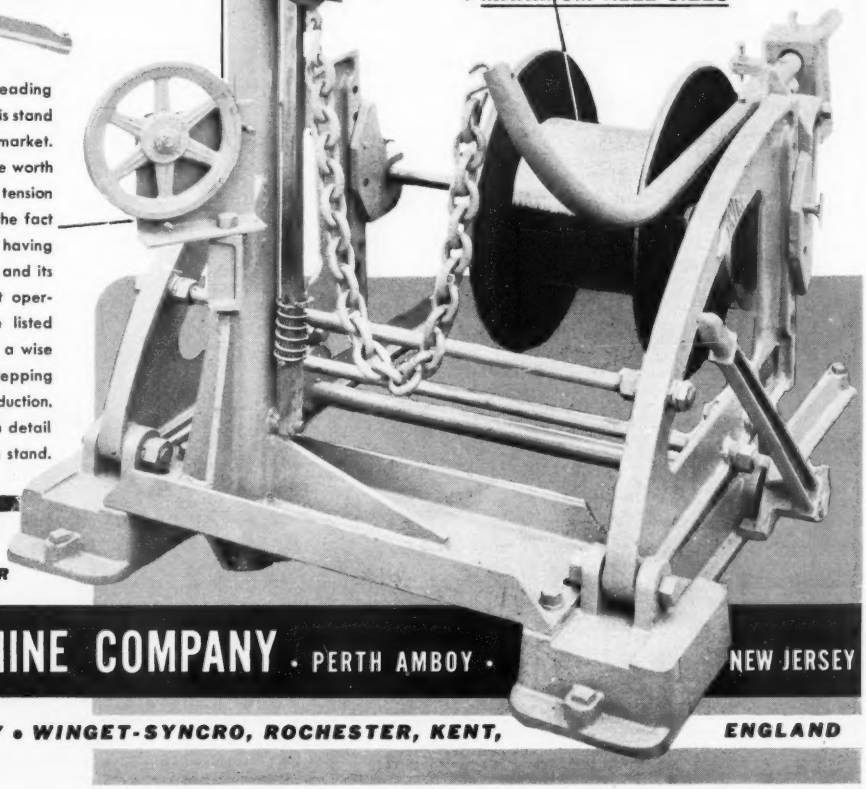

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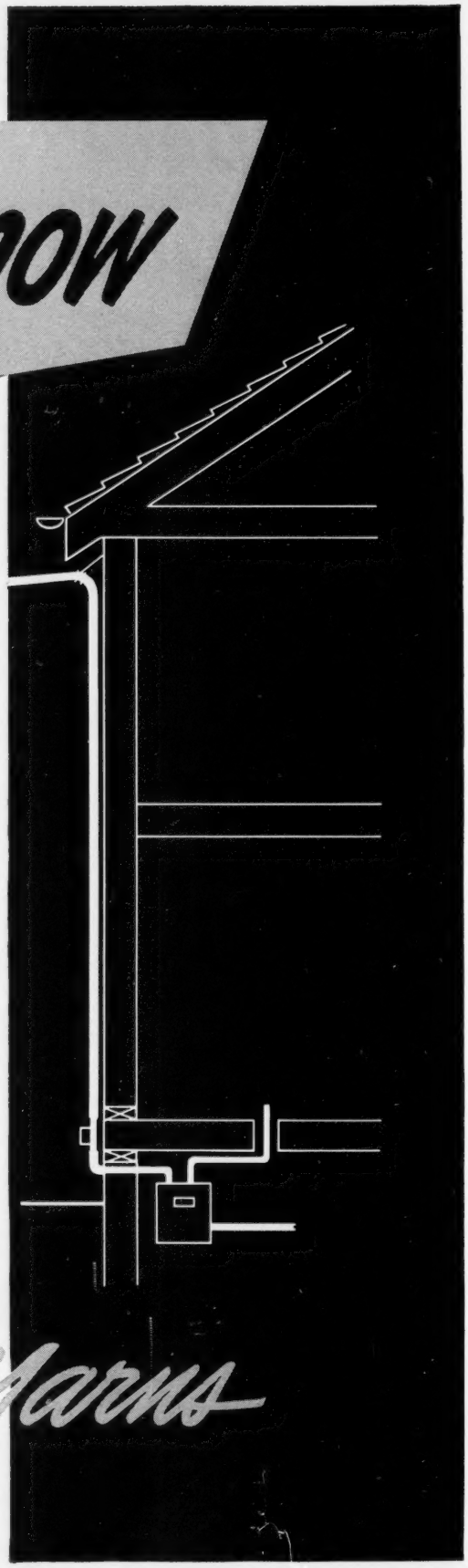

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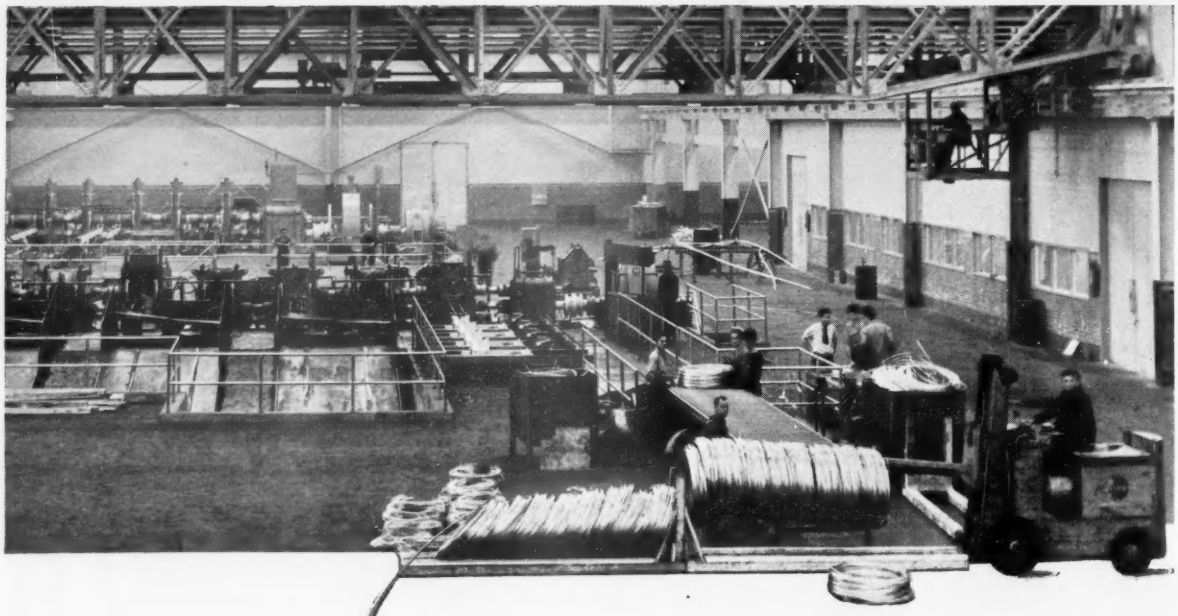

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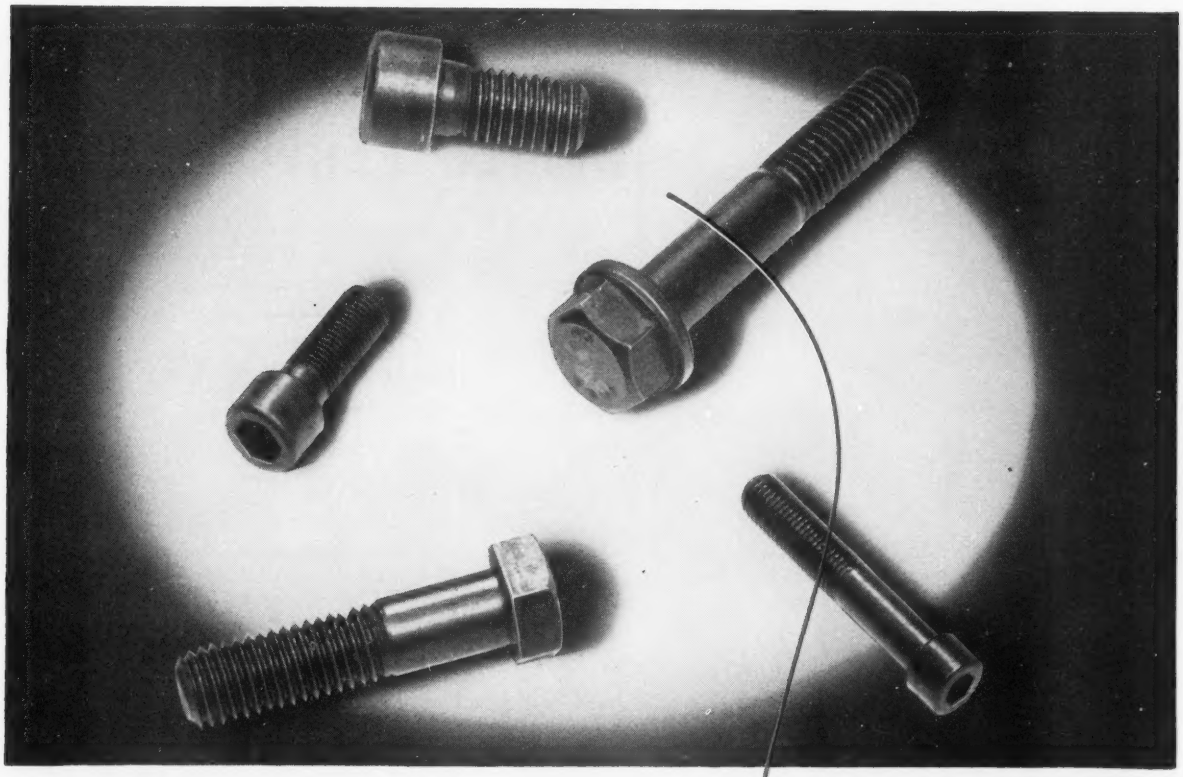
in U·S·S Amerloy Wire



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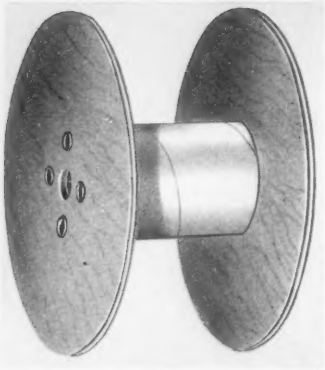

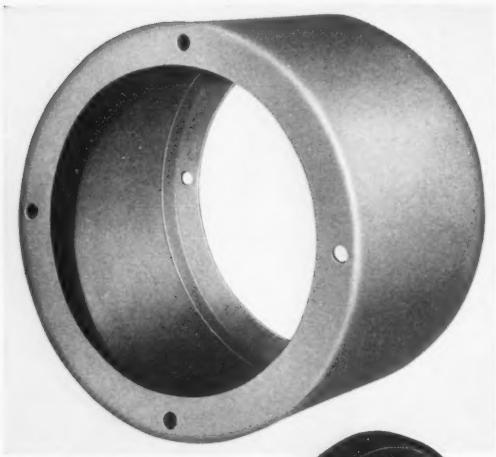

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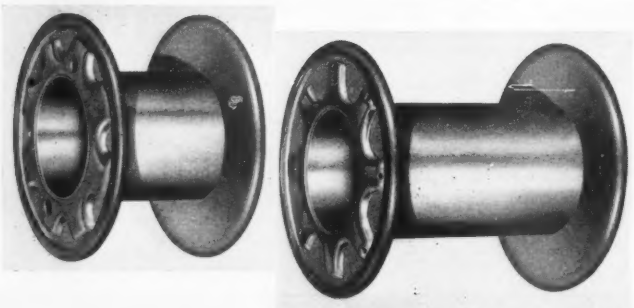

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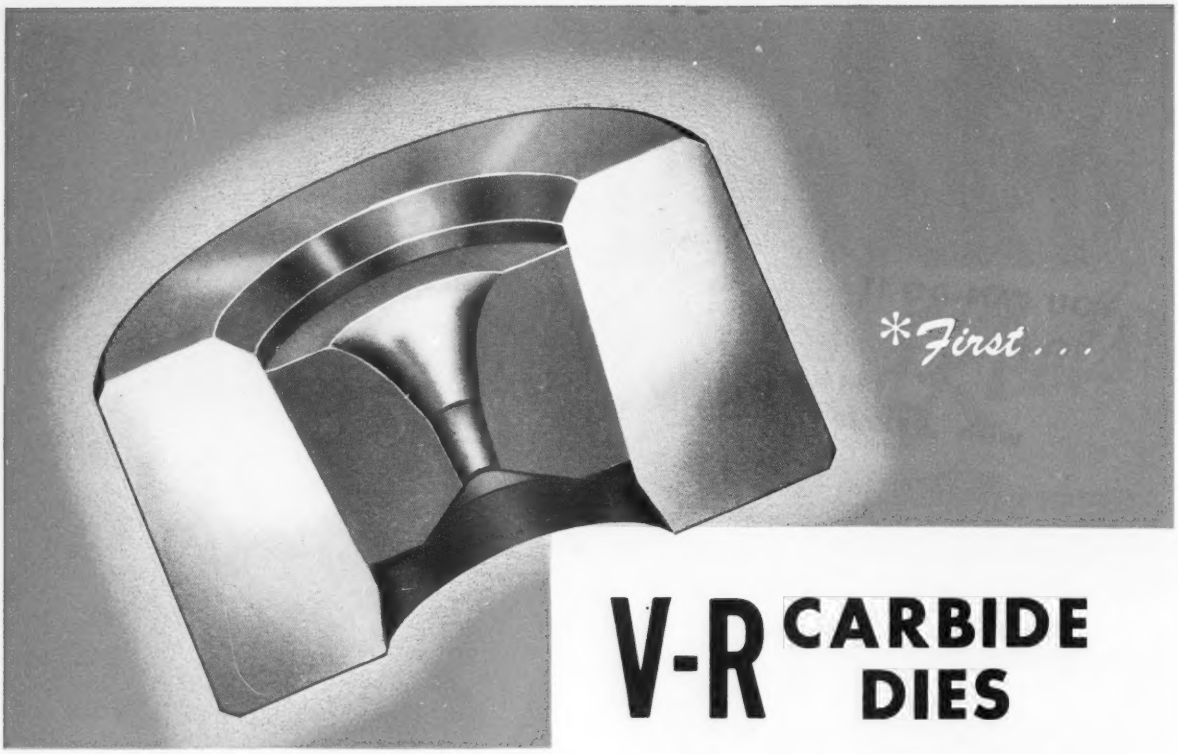

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The Wire Outlook

What's Ahead For 1950?

Business, good in most quarters, is likely to remain active through the year. There is wide agreement that the first half will show up well, but some question as to the second. The tone should remain firm through the entire year, as the forces of expansion, once started upward, tend to unfold progressively.

Steel production, which came back fast, will continue at high levels, with shortages for users during the first four or five months. Automobiles will be turned out at record rates until Summer, at which time it is expected that makers will have caught up with their backlogs. After that production schedules may be cut, reducing the demand for automotive springs and wire. Employment has again risen to nearly 60,000,000. A dip is forecast for the Spring, with jobs again rising by mid-summer to a post-war high.

Throughout 1950 there will be a gradual extension to small businesses of the welfare provisions forced on big operators, which may cause some disruption in their present simple manner of doing business by making necessary additional capital, paper work and price adjustments. We can look for more upward price revisions in 1950 to provide the wherewithal to pay for the new industrial pensions. One large steel firm estimates that it will require a fund of 10 million dollars to provide for their 20,000 employees. The turn of events has killed most plans for further plant expansion programs, but industry will continue to modernize by replacing worn and obsolete equipment in an effort to lower production costs. We should now be entering a short era of comparative industrial peace, but that does not mean that trials of strength will not be resumed when present contracts expire. In the breathing-spell it would be desirable for large employers to seek to discover ways and means to improve employer-employee relationships from the top levels down through the ranks. Every test of strength won by labor leads only to a further degree of inflation.

Labor leadership has in some quarters exhibited an enlightment in securing gains without paralyzing strikes. The how and why of this might well be learned and applied. This is the time to start a joint study of labor relationships by industry, labor and government, aimed at the avoidance of future major shut-downs of industry, whatever the seemingly justifiable complaint. If past methods of settling labor disputes have proved anything, it is that the use of coercive strikes has caused everyone to lose more than can be made up by the "gains."

Sellers' backlogs of wire products range from eight to ten weeks. Probably there will be no formal allotment distribution plans on wire products, but some steps will be taken by most concerns to make their distribution to customers as equitable as possible. Rod producers, because of their own accumulation of orders will limit acceptance of orders from non-integrated mills until they catch up with their own needs. Seasonal demand may stimulate fencing and barbed wire orders in the coming months. Jobber stocks of nails in popular sizes are in many instances badly depleted. Wire for automobile and furniture use, tight before the strike, has become more stringent. Manufacturers' wire demand is very strong.

Most industrial fastener manufacturers maintained a fast pace of production through the strike, but practically exhausted their rod and wire stocks; production will be slower until these stocks can be built up again.

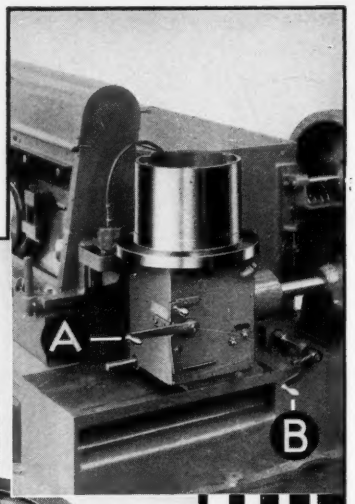
Electric wire and cable producers are going full blast, in contrast to the slowing down that started before the beginning of this year and continued into the summer. Aluminum supply is now plentiful, with additional major producers having entered the field with large new facilities. Brass and copper are in good supply with the demand for rod and wire for non-ferrous wire products running at satisfactory levels.

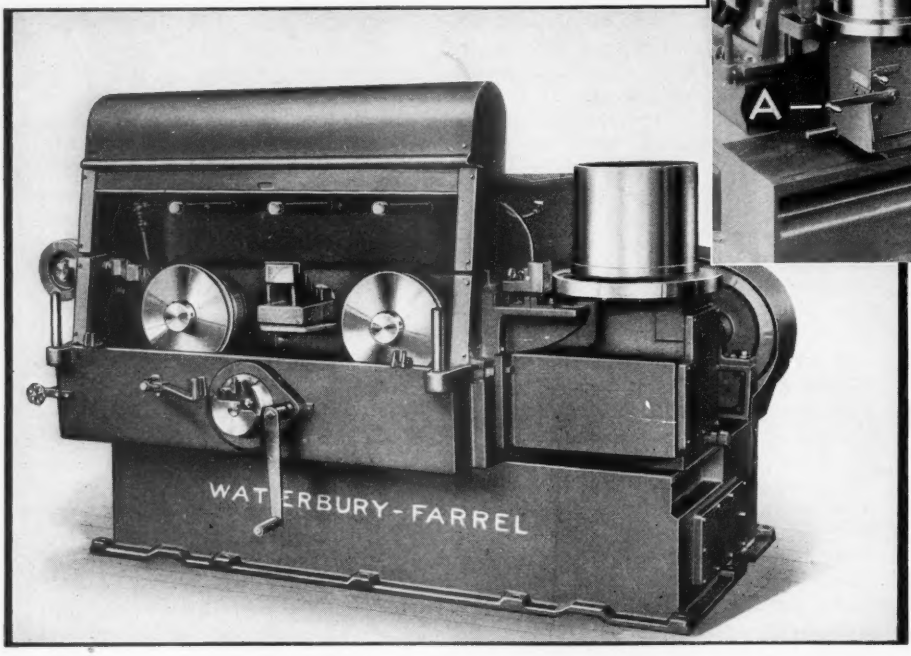
A consideration that continues to gnaw at the fiscal soundness of the country is the pace of Federal expenditures. In the face of all that is being said on this question, the outgo grows constantly with pressure by the Administration for higher taxes. This cannot go on forever and the unawareness on the part of the government of a need for economy, balancing of the budget and reduction of taxes is distressing to those whose minds run in common-sense channels. We may achieve a national income of 300 billions, Mr. Truman's goal, but only through inflationary policies that will not provide additional goods for the consumer. His income may go higher, but so will the price of what he buys. Net: no advantage.

For the time being we will coast along successfully in a period of active business, possibly for four or five years; perhaps a decade. But some day the effects of continued improvidence and extravagance must have a reckoning.

—from the Editor's Desk

WIRE DRAWING MACHINES





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Vol. 25 JANUARY, 1950 No. 1

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— ASSOCIATE EDITORS —

Kenneth B. Lewis, Consulting Wire Mill Engineer

Lancaster, Allwine & Rommel, Consultants on Patent Information

Richard E. Brown, General Manager

R. S. Spengel, Business Manager

E. D. Sickels, Advertising Manager

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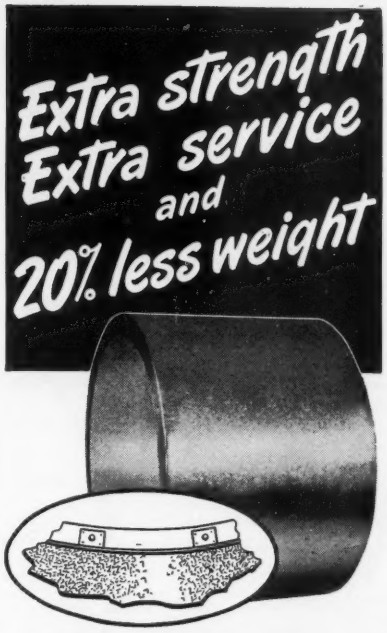

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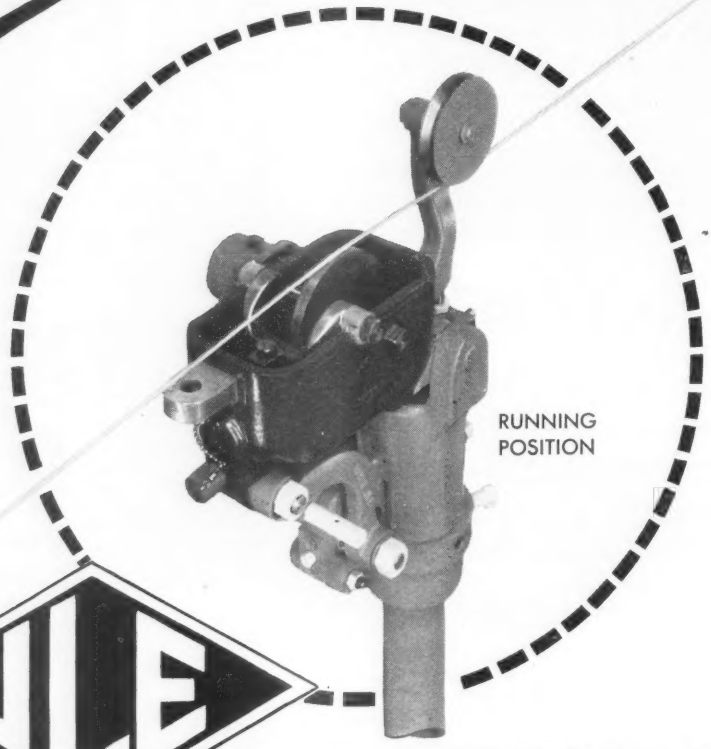

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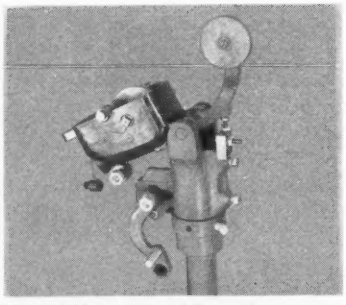

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The Corrosion of Steel and Its Protective Metallic Coatings

By Allan B. Dove, F.C.I.C., M.E.I.C.
Superintendent, Dominion Works,
The Steel Company of Canada, Limited
Lachine, Quebec, Canada

A paper prepared as the Mordica Memorial lecture and given before the Wire Association, October, 1949, at Chicago.

MR. President, Ladies and Gentlemen. I am deeply appreciative of the honour of being the ninth to give the Mordica Memorial Lecture. There is no doubt John Mordica was one of the most practical of all Wire Mill men. It is, therefore, necessary that I, in giving the Mordica Memorial Lecture, should try and be practical in describing my subject. It will be recognized that it is extremely difficult for the ninth Lecturer to attempt to give something new. I have, therefore, chosen a subject which has not been dealt with completely during the last nine years namely that of the aspects of corrosion of steel and of the protective metals which are normally used to cover steel.

* * *

AN appreciable tax is being imposed daily upon our very living by the simple chemical, or series of chemicals, known as iron oxide. We cannot argue that iron is not the most important metal in our era, but it is the most wasted one. 15 billion dollars—the amount originally set aside by the United States for Defense in 1949—is one estimated figure of the annual waste induced by CORROSION, the arch-fiend who gnaws daily at our very economic vitals.

* * *

Definition

THE corrosion of metals is defined as the attack of a metal by chemical or electrochemical action; it must be distinguished from "erosion," or the mechanical attack—a good example of which is the grinding of metal to dust. Should the metal fibres be continually in motion, corrosion which might slow down or even cease in still metal in solution, may continue unabated as fresh metal is made available to the corrosive chemicals. This happens when breakage occurs under corrosion fatigue, or when corrosive gases scarf metals at high temperature and high velocity.

* * *

J. ROBERT OPPENHEIMER, President of the American Physical Society and chairman of the Chemical Advisers to the Atomic Energy Commission has said "What we do not understand we explain to each other." Corrosion may well be the one of those subjects which we do not understand fully but on which we now have a working theory which will become clearer under discussion.

* * *

The Types of Corrosions

RUSTING is favoured by five points:

(a) **Impurities in the metal**
(b) **Contacts of foreign "noble metals"**
(c) **The presence of moisture**
(d) **The presence of carbon dioxide**
(e) **Oxygen**

* * *

CORROSION may occur generally in two ways—**direct chemical** attack or **electro chemical** attack. Since chemical action itself is accompanied by a transfer or a displacement of ions it may be regarded as a form of electrochemical attack.

* * *

ELECTRO chemical action may be of two general types (1) Galvanic Cell, (2) Concentration Cell. These types of attack are distinguished by a simple method: Whereas in Galvanic corrosion the current results from the action of gases and liquids upon two unlike metals connected with each other, in the Concentration Cell, the current results from different concentration within a liquid acting upon a single metal.

* * *

I REALIZE that the problem of making the subject of Corrosion understandable will be a difficult one. **Dr. George Russell Harrison** of M.I.T. pointed out the need of clarity by telling the story about a plumber of foreign birth who wrote the National Bureau of Standards to the effect that he had found that hydrochloric acid would work wonders in clogged drains. He wanted to know whether its use would do any harm.

* * *

THE Technical members of the Bureau Staff replied "the efficiency of hydrochloric acid is indisputable but the corrosive residue is incompatible with metallic permanence." The plumber wrote back and thanked the Bureau for telling him that his method was O.K. This upset the Federal scientist, so he consulted his superior who then wrote the plumber "we cannot assume responsibility for the production of toxic obnoxious residue with hydrochloric acid and

IN MEMORIAM

JOHN MORDICA
1873-1937

suggest that you use an alternative procedure."

★ ★ ★

EVEN this did not close the file. The plumber replied how glad he was that the Bureau was crazy about hydrochloric acid for use in drains. In despair the two scientists appealed to the Head of the Bureau. He closed the file by dictating "Don't use hydrochloric acid. It eats hell out of the pipes." The plumber found that statement understandable and quotable. It, therefore, becomes necessary that I make my subject both understandable and quotable.

★ ★ ★

Early Corrosion Studies

LUIGI GALVANI in 1780 made an eminent discovery, which was published in 1791, when a series of accidental observations on frogs' legs led to a most remarkable series of conclusions. First the frogs' legs were dissected on a crowded table so close to a static electrical machine in operation that sparks jumped over the scalpel. They also happened to be in contact with the crural nerves, and the dead frogs' legs twitched violently. **Galvani** investigated at once and he found that the twitching was easily reproducible and that atmospheric electricity during thunderstorms caused the same effect.

★ ★ ★

HE also found that when dead frogs were hung on copper wall hooks fastened to an iron railing their legs would convulse again. This second observation which involved a bi-metallic couple, that is, a couple of two different metals, was not accompanied by sparks from the static machine and there were no lightning flashes at the time. **Galvani** took the frogs down and tried to make a final analysis with other pairs of metals. The frogs obligingly jumped for a number of other pairs than iron and brass but not with the substances we now call electrical insulators.

★ ★ ★

IT must be recalled that **Luigi Galvani** was an anatomist, but he was now quite convinced that the Goddess of Wisdom wished him to make some experiments in Physics. **Galvani's** publication in 1791 of observations on couples and frogs' legs—apart from starting a wholesale massacre on frogs—probably set the physicists on the path which led to our present theory and understanding of corrosion. **Alessandro Volta** deserved the thanks of the frog world when he showed that the frog could be dispensed with, and that current still flowed between certain pairs of metals. Some physicists of the period had gone so far as to connect fourteen pairs of frogs' legs in series, but, it has been pointed out, [1] this powerful device did not open up any new industries.

★ ★ ★

FOLLOWING Volta's work, **J. W. Ritter** showed that when two metals are moistened and brought into contact, as described by Volta, corrosion of one of them proceeds more rapidly than when they remain separate.

★ ★ ★

IN a practical sense, the phenomenon of galvanic corrosion had been described long before Ritter's birth . . . or even the publication of Galvani's famed report on "Animal Electricity." In 1761 the British frigate **"H.M.S. Alarm"** returned from a long test voyage to the West Indies. As protection against the terido, this vessel's bottom had been sheathed with 12 oz. copper for the first, seriously studied Admiralty sheathing experiment. The now-famous report [2] reads, in part as follows—

"We were greatly surprised to perceive the Effect the Copper had had upon the Iron where the two metals touched; but it was most remarkable at the Rother (rudder) Iron and in the fastenings of the false Keel, upon the former, the Pintles and Necks of the Braces were as corroded and Eat, —particularly the two lower ones, that they could not have continued of sufficient strength to do their Office many Months longer, and with respect to the false Keel it was entirely off.

"The loss of the false Keel was at first supposed to have happened from the Ship having been on Shore, but upon examining it, the Nails and Staples that fastened it were found dissolved into a kind of rusty Paste; which was also the case of every Nail that had been used in fastening on the thick Lead to the Gripe and fore part of the Knee.

★ ★ ★

"The same effect, but not to so great a degree; was observable upon all the Bolts and Iron under water, except where brown paper (with which the bottom was covered) remained undecayed, and thereby separated the two Metals; and where this covering was perfect, the Iron was preserved from injury. We arrive at the conclusions:

"1st.—That as long as Copper Plates can be kept upon the bottom, the Plank will be thereby entirely secured from the Effect of the Worm.

"2nd.—That neither the Plank or caulking received the least Injury with respect to its duration, by being covered therewith.

"3rd.—That Copper bottoms are not incident to foul by Weeds, or any other Cause.

"All which are Advantages very desirable to be attained, provided Methods could be fallen upon to obviate the difficulties we have before pointed out; the greatest of which is, the bad effect that Copper has upon Iron.

"It has been shown that where brown Paper continued perfect between them, the Iron was not injured, whence We presume, if the Heads of the Bolts and other surfaces of Iron were covered with flannel and a very thin leaf of Lead, they could be better secured from the corrosion of the Copper, and with respect to the Rother Irons, if the back and sides of the Stern Port and sides and bearings of the Rother were also covered with thin Sheet Lead instead of Copper, the effect that has appeared upon the Pintles and Necks of the Braces would be kept at least a greater distance and though We doubt it would not answer the end of entirely securing the Rother Irons, and it might lengthen their Service beyond the hazard of failing within a three Years Station.

"As to the difficulty about the false Keel, that may be got over by having all the Staples made of Copper."

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IT should be noted that this valuable statement is dated August 31, 1763. Had all the information in this report been seriously digested and generally applied at the time, the study of corrosion in general, and of galvanic corrosion in particular, would have been greatly forwarded, and many years of economic loss averted. It will be seen that these investigators understood, 186 years ago, that the particular difficulty that they were studying was caused by certain unsuitable combinations of metals in contact, and that insulation produced desirable results. It

will also be noted that the writers of the report recommended that copper staples (instead of iron) might have prevented loss of the false keel. These results are still among the most important practical rules for averting or minimizing galvanic corrosion, and early recognition of these important facts would have been of inestimable value. Take for example the case of the yacht "Sea Call." This vessel was built in 1915 using a monel metal hull, and due to an error steel rivets were used for some fastenings. Because of the larger area of monel to steel, galvanic corrosion was almost immediate, and the yacht was scrapped early in its life. Had the owners of the "Sea Call" in 1915 known the results achieved by the British Admiralty in 1763, there is no doubt that the loss of a good vessel could have been avoided.

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BENJAMIN FRANKLIN in 1786 in writing to his friend **Benjamin Vaughn** on the subject of "corrosion in distilling New England rum" made the statement

". . . . and you will observe with concern how long a useful truth may be known and exist before it is generally received and practiced upon."

★ ★ ★

The Galvanic Series

AS was demonstrated by **Signor Galvani** in 1763, during the corrosion process an electric current is generated by the two metals in contact, and the magnitude of this current is equivalent to the acceleration of the corrosion of the more vulnerable material beyond its normal rate. In general the reaction is similar to that of a miniature cell, or battery, from which a very definite amount of electrical power may be derived. The simplest and best-known example of the galvanic cell is the one composed of zinc and copper joined together by a metallic conductor and immersed in a dilute solution of sulphuric acid. It is also well known that in this cell the less noble zinc suffers accelerated corrosion, while the more noble copper is virtually unattacked.

★ ★ ★

WHEN one has the knowledge of the corrosion behavior of metals and alloys, it becomes possible to arrange them in a series which will indicate their general tendencies to form galvanic cells, and thereby predict the probable direction of the galvanic effects. Such a series is shown in Table 1.

★ ★ ★

TABLE 1: GALVANIC SERIES OF THE METALS

GALVANIC SERIES OF METALS AND ALLOYS
Corroded End (Anodic, or Least Noble)
Magnesium
Magnesium alloys
Zinc
Aluminum 2 S
Cadmium
Aluminum 17 ST
Steel or Iron
Cast Iron
Chromium-iron (active)
Ni-Resist
18-8 Stainless (active)
18-8-3 Stainless (active)
Lead-tin solders
Lead
Tin
Nickel (active)
Inconel (active)
Brasses
Copper
Bronzes
Copper-Nickel alloys
Monel
Silver solder
Nickel (passive)
Inconel (passive)
Chromium-iron (passive)
18-8 Stainless (passive)
18-8-3 Stainless (passive)
Silver
Graphite
Gold
Platinum
Protected End (cathodic, or most noble)

Those metals high in the series will corrode in favour of lower metals if both are exposed to the same conducting solution and at a rate proportional to the distance between them in the Table.

★ ★ ★

TABLE 1 is based on actual corrosion testing experience with numerous corrosives in the laboratory, under operating conditions, and on practical results with metals and alloys in long service. It should be warned that this series should not be confused with the familiar "Electromotive Series" which is found in many textbooks and is of value in physical chemistry and thermodynamic studies. Since the metals in the "Electromotive Series" are arranged according to the potentials possessed by them when immersed in solutions of a definite strength, namely in concentration containing one mole per liter, the Electromotive Series cannot be relied upon to predict the potential differences between metals in the general case, and it generally cannot be used to predict the amount of accelerated corrosion or the result of contact between two metals.

★ ★ ★

TABLE 1 has a basic characteristic which makes it analogous to the "Electromotive Series" but this Table takes into consideration over-all and practical aspects in addition to theoretical principles.

★ ★ ★

IT will be noted that some of the metals in the Table have been grouped together. These group metals and members have no strong tendency to produce Galvanic corrosion on each other, and from the practical standpoint they are relatively safe to use in contact with each other. On the other hand any coupling of any two metals from different groups separated from each other in the list will result in the galvanic, or accelerated corrosion of the one higher in the list. This effect becomes more pronounced the greater the distance between the metals in the group. The farther apart they stand the greater will be the galvanic tendency.

★ ★ ★

Factors to Minimize Galvanic Corrosion

THE **International Nickel Company**, in their "Inco Corrosion Report Volume II No. 3," has suggested the following methods to minimize galvanic corrosion:

(1) Select combinations of metals as close together as possible in the Galvanic Series.

(2) Avoid making combinations where the area of the less noble material is relatively small. As the British Admiralty suggested in 1763, it is good practice to use the more noble metals for fastenings, or other small parts, in equipment that is built largely of less resistant material.

(3) Insulate dissimilar metals whereever practical. If complete insulation cannot be achieved, anything such as a paint or plastic coating at joints will help to increase the resistance of the circuit.

(4) Apply coatings with caution. For example, do not paint the less noble material without also coating the more noble, otherwise greatly accelerated attack may be concentrated at imperfections in coatings on the less noble metal. Keep such coatings in good repair.

(5) In cases where the metals cannot be painted and are connected by a conductor external to the liquid, the electrical resistance of the liquid path may be increased by designing the equipment to keep the metals as far apart as possible.

(6) If practical, add suitable chemical inhibitors to the corrosive solution.

(7) If you must use dissimilar materials well apart in the series, avoid joining them by threaded connections, as the threads will probably deteriorate excessively. Brazed joints are preferred, using a brazing alloy more noble than at least one of the metals to be joined.

(8) If possible, install relatively small replaceable sections of the less noble material at joints, and increase its thickness in such regions. For example, extra heavy wall nipples can often be used in piping, or replaceable pieces of the less noble material can be attached in the vicinity of the galvanic contact.

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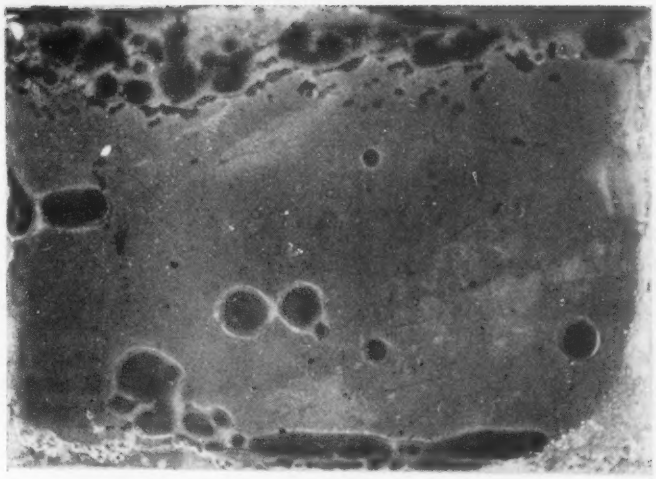
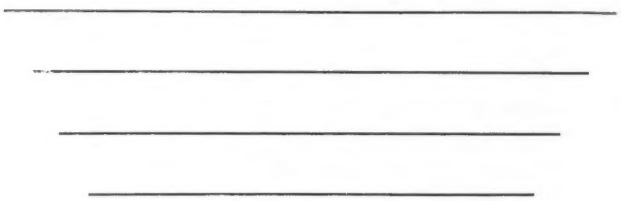


Fig. 1—Larger cut—Cathodic Areas in Boiler Plate indicated by Blue Areas.

Smaller cut—Cathodic and Anodic Areas in Wire.

Fig. 1—Cathodic and Anodic Areas in Steel Samples as indicated by the Ferroxyl Test. (For text see Page 32b)



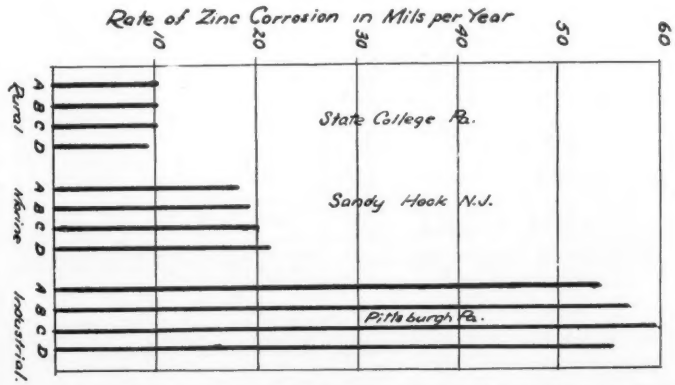


Fig. 3—Influence of Wire Size and Location on Corrosion of Hot Dip Galvanized Wires.

Legend:—

A — 6 ge wire

B — 9 ge "

C — 11 ge "

D — 14½ ge "

All Wires Hot-Dipped Galvanizing.

(For text see Page 33)

Protective Films

MOST metals in reaction with oxygen, with or without the presence of water, would be expected to disappear altogether were it not that the products of corrosion form a film which tends to produce an insulation between the corroding agent and the metal. Effective insulation may take place before the film becomes visible to the naked eye. Should the intermediate products of corrosion be soluble in the corroding agent, however, the action will proceed to the right in accordance with the chemical law of Mass Action, and the metal will be rapidly destroyed.

* * *

Multiple Attack

IN some cases metals may enter solutions as one oxide or hydroxide and may be precipitated as a less soluble oxide or hydroxide. Under these conditions the protective coating disappears from the equation as a precipitate, and attack on the metal continues. If there should be sufficient oxygen available in the solution, however, the hydrated ferric oxide may be formed in contact with the metal and insulation as in the case of direct action, soon stifles the reaction.[7]

* * *

Electrochemical Attack

ELECTROCHEMICAL attack may be set up by one or more metals so long as anodic and cathodic areas are present.

* * *

THE heterogeneous nature of steel itself assists the formation of anodic and cathodic areas. In Fig. 1 we have shown colour photographs of areas set up in a single piece of boiler plate and in the cross section of a headed bolt. These areas were developed by the use of "Ferroxyl Test."[8] Ferrous ions are formed at the **negative** portions of the metal—by the dissolution of the base metal, iron—and they react with the ferricyanide to produce blue coloration. In positive areas, hydrogen ions are discharged, coloring the area—oxidized by ferricyanide to alkalinity—a distinctive pink. (See 32a)

* * *

IT would be assumed that a perfectly homogeneous metal would not be attacked, but this concept is of little value since it appears impossible to obtain uniformity. Even a single crystal, **Glasstone**[4] points out may have different potentials at different faces, hence corrosion would occur even in this ideal state. This was recently verified[5] by tests at **University of Virginia Laboratory.**

* * *

TO make the point of anodic and cathodic areas even more disturbing, **Evans**[6] has shown that, in the case of a single drop of solution on a metallic surface, the **center** or least accessible portion to oxygen, automatically becomes anodic, and the metal enters the solution as a soluble salt. The **edge** of the drop, where oxygen is available, is always cathodic. It thus becomes apparent that those portions of a metal **least** accessible to oxygen are most prone to undergo corrosion, whereas those most accessible to oxygen are less likely to corrode.

* * *

Part II—Protection by Low Alloys

PRIOR to 1900 little was known —or cared—of the inherent corrosion resistance of certain alloying elements in steel. Although the influences of copper on corrosion were mentioned from 1627, it was not until 1900 that **Stead** and **Wigham**[28] reported a series of experiments on "the effect of copper on steel for wire making." These experiments were carried out in Middlesborough, England, by immersion of the samples in town water for a number of weeks. It was later noted by **Breuil** and **Walker,** as reported in the **Proceedings of the A.S.T.M.** in 1911, that copper had a marked influence on the resistance of steel to attack by sulphuric acid. **Buck**[29] by systematic investigation showed that the addition of relatively small amounts of copper (0.01 to 0.30%) in both Open-Hearth and Bessemer Steels greatly increased the resistance of sheets to perforation in the atmosphere. Wire came prominently into literature in 1917 as a result of the investigation by **Storey**[30] of the corrosion of steel fence wire. **Storey** definitely established the beneficial effect of copper in resisting corrosion. In the same year **Thomas** and **Blake** established that alloys formed by additions, in small amounts, of copper, nickel and cobalt to certain irons are more resistant to atmospheric corrosion than the irons themselves.

* * *

IT is clear now after some 50 years of tests and study on the subject of low alloys, that the additions of such alloys can be determined only by consideration of the environment and exposure conditions. For example, in some twenty positions, **Hudson**[31] reported widely varying attack, as shown in figure No. 2.

* * *

IT appears that chromium, nickel and molybdenum may increase corrosion resistance in many waters, but tests on chromium addition over a two-year period[32] indicate that a 2% addition of chromium is necessary to obtain even a 50% improvement in loss of weight. In soil too, **Logan**[33] in the authoritative "Journal of Re-

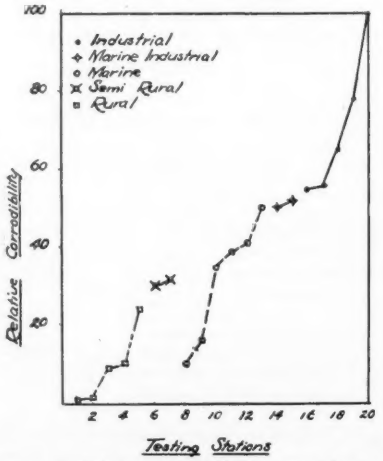


Fig. 2—Relative Atmospheric Corrosion at Twenty Locations Throughout the World. These results, reported by J. C. Hudson, were tests made upon 2-inch by 4-inch specimens of Open Hearth Iron (0.07% Cu.) during a test period of one year.

search "reports" while the addition of small percentages of certain alloying elements improves somewhat the resistance of ferrous alloys in some soil conditions, the improvement cannot be considered significant. Ferrous materials must contain very considerable quantities of nickel, chromium or other elements if they are to withstand the action of severely corrosive soils."

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IT will be of interest at this point to discuss the methods by which material should be tested to determine how it will re-act to a certain environment. **Circular No. 346 of the Bureau of Standards** has become an almost historical document, because of the conclusions drawn in this circular in regard to the method of testing samples for reaction to corrosive atmosphere.

★ ★ ★

IN the summary on page 445 of volume 23 of the Technological Report of the Bureau of Standards we find this statement: — "The corrosion rates, in order of relative corrodability of the materials, were found to vary very considerably for the different test methods: thus showing that a corrosion test designed to give information concerning the suitability of a metal for some particular type of service should embody the essential features of the service which is to be met."

★ ★ ★

Part III—Protection by Metallic Coatings

THE protection of iron and steel by metallic coatings is one of the most interesting phenomena for Metallurgical study. With a few exceptions, advance has been slow in the past ten years in coating methods or materials. Zinc and cadmium are still the favorite anodic coatings for steel against atmospheric corrosion; tin is still a preferred metal for food contact protection; chromium copper and nickel still beautify indoor and outdoor equipment; lead is still sometimes doubtfully regarded as a Quisling protection.

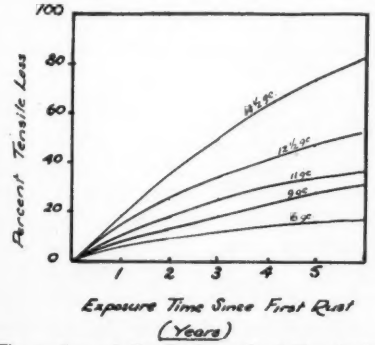

Fig. 4—Loss of Tensile Strength of Zinc Coated Wires Subjected to Outdoor Exposure at Pittsburgh, Pa. (11).

★ ★ ★

Zinc Coatings

THE history and methods of application of hot and electrogalvanized coatings have already been fully covered and described by **Mr. Fred Crapo** in the **1946 Mordica Memorial Lecture.** The practice of galvanizing probably originated with **Melouin** of France in 1741. In general, there are four main methods by which zinc protection may be applied to iron and steel articles:

Hot dip galvanizing
Electrogalvanizing
Sherardizing
Spraying (Schoop Process)

★ ★ ★

THERE is in actuality no great difference in the protection afforded by equivalent weights of zinc on steel, [8,9] the main differences appear to lie in the slight variations afforded by comparable layers of zinc and its alloys. Indeed the appearance after a corrosion period appears to be better the thicker the layer of pure zinc. The tests have indicated [10] that the rate of corrosion of zinc in the atmosphere is approximately 1/10-1/20 that of mild steel. The rates of corrosion to be expected under different atmospheric exposure conditions as given by various investigators [9] are as follows:

Rural Atmosphere —
0.06 oz./sq. ft. per Year
Marine Areas —
0.07 oz./sq. ft. per Year
Industrial Areas —
0.1-0.4 oz./sq. ft. per Year
In certain rural areas, corrosion rates as low as 0.02 oz./sq. ft. per Year have been noted.

★ ★ ★

THE greater rate of corrosion in industrial atmospheres is no doubt largely caused by the presence of Sulphur Dioxide (SO_2) and Sulphur Trioxide (SO_3) which increase the acidity of condensed moisture and yield soluble zinc compounds. In other words a soluble salt is made which is washed off by natural moisture. In Marine and Rural areas, basic carbonate which protects the underlying layers may be expected to be formed.

★ ★ ★

THE **A.S.T.M.** and **British Iron & Steel Institute** have probably done more work to date on the subject of corrosion tests than have any other organizations in the world. The **A.S.T.M.** has, moreover compiled complete results over more than twenty years in various types of atmosphere; many of these tests have been carried out in cooperation with such bodies as the **National Bureau of Standards, American Electroplaters Society** and the **Electrochemical Society.** Excerpts from one such group of tests, completed in 1932, are shown graphically in Fig. 3. This figure summarizes the corrosion losses on four sizes of wire in three different atmospheres.

★ ★ ★

IN Pittsburgh and Sandy Hook the smallest gauge wires lost zinc at a rate 10-20 percent faster than the largest. At severe locations, the A.S.T.M. tests show, the loss of zinc in the first year of exposure is 5-15% greater than the loss in succeeding years.

★ ★ ★

NOW let us consider further the influence of wire size upon corrosion rate. Probably because of the greater continuity of moisture films on fine wire, we can expect an increased corrosion attack upon the zinc, and as rusting progresses the tensile value will fall more rapidly as shown by Figure 4. Exposure data is not nearly complete, but information thus far obtained tends to indicate that steel does not start to lose tensile strength until most of the zinc has been removed and the steel base is rusted.

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Effects of Purity of Coatings—Hot Galvanized Wire

INSOFAR as atmospheric corrosion is concerned, it is reported that Lead, Cadmium and Tin in hot dipped coatings of zinc up to a few tenths of one percent are not detrimental, but Copper and Antimony are objectionable.[12] Prost[13] had said that Arsenic, Antimony, Copper and Tin separately or together greatly increase the tendency of the zinc to dissolve in acids.

★ ★ ★

IN water systems, the life of zinc coatings is, at present, unpredictable. The degree of electrochemical protection afforded by zinc coatings to steel is a function of the conductivity of the surrounding medium; for example, in sea water, zinc may protect **exposed** steel to a distance of several inches, but in pure water, small **exposed** areas will rust in even a short time. The Iron-Zinc layer near the steel is not so readily attacked as the pure zinc layer, hence the steel may rust and pit whilst alloy layers still exist. In hot water pipe systems, the conditions become even more puzzling; between 120°-150°F. zinc coating affords little protection to **exposed** steel.[14] It is suggested that this may be due to electrical insulation of zinc by its corrosion products, or because at this temperature range the potential between zinc and steel becomes small — as a matter of fact it appears that zinc may even become cathodic to exposed steel.

★ ★ ★

THE **Committee on Steel Pipe Research of the American Iron & Steel Institute** recently reported[16] that the tendency of zinc coating, or galvanizing, on steel water pipe to dissolve varies with the substance in solution in the water. In studying exceptional cases of bad pitting it was found by the **A.I.S.I.** that bicarbonates and nitrates accelerate the reversal of the normal relationship, but chlorides and sulphates prevented the reversal. It now appears, therefore, that these various salts as well as the temperature of the water have a profound influence on the rusting of galvanized water pipe.

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MOST impurities in zinc apparently do not affect its protective value in aqueous solutions. **The New Jersey Zinc Company,**[15] however, has reported that 0.2% Tin accelerated failure and rusting of steel under these conditions.

★ ★ ★

Electrogalvanizing vs. Hot Dipped Wires

DEPENDING upon the type of exposure, electrogalvanized and hot dipped wire comparisons may be often confusing. **A.S.T.M./A.E.S.** atmospheric corrosion tests, commenced in 1932, indicated that the average corrosion rates on sheets in comparable locations gave values as follows:[17]

Hot Dipped	**0.17 Mils/annum**
Electrogalvanized	**0.14 Mils/annum**
and for comparison Sheet Zinc	**0.12 Mils/annum**

★ ★ ★

THESE relationships have been borne out in tests conducted in industrial atmosphere on chain link fence galvanized before forming. Again in "mild locations" characterized by tests at Washington, D. C. the rate of failure of hot dipped sheet was almost twice that of electroplated samples. Tests conducted by the **Bell Laboratories in New York,** however, indicated that electroplated zinc coated sheets lost weight a little more rapidly than hot dipped.[12, 18]

★ ★ ★

TO attempt to summarize generally for all atmospheres and conditions, the writer is reminded of Samuel Clemens' character in "The Child of Calamity" who said, "I was glad to be able to answer promptly, and I did, I said, I didn't know."

★ ★ ★

Chromate Coatings on Zinc

ZINC, which corrodes evenly in outdoor atmospheres to form thin protective corrosion films, corrodes rapidly and unevenly in contact with highly aerated waters and stagnant waters. The corrosion product is bulky and pitting may soon become pronounced. The **Cronak** process, described by **Anderson**[19] deposits a basic chromium chromate of the general formula $Cr_2O_3 . CrO_3 . x\ H_2O$. With a film thickness of about 0.02 mils, it is produced by a simple immersion in a solution containing dichromate ion ($Cr_2O_7 =$) and sulphuric acid.

★ ★ ★

THE chromate film so formed is yellow, golden or olive green depending upon the process used. Tests reported by **Anderson**[19] indicate that without chromate protection corrosion products appeared on hot galvanized sheet in stagnant water in one day; in the case of chromate finishes in thirty eight days. Rust appeared on unprotected sheet in 90 days, on chromated sheet in 998. Perforation occurred on unprotected sheet in 588 days and in chromated sheet in 1768 days. Surely this process is worthy of some application in our wire industry?

★ ★ ★

Sherardizing

THE **Sherardizing** process was developed by **Sherard Cowper-Coles** about the beginning of this century. This process makes use of the ready formation of Zinc-Iron alloys by the cementation process. The product to be plated is tumbled with finely divided metallic zinc at 600° to 700°F. and cooled slowly to produce a matte finish, ductile coating. The coating consists of a Zinc-Iron series identified as $FeZn_3$ at the base to $FeZn_{10}$ at the surface. The coating constitution varies according to the time, temperature and additives used.

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IN atmospheric corrosion, it has been determined[20] that hot-dipped coatings and Sherardized coatings of the same weight have approximately the same life. Furthermore, tests conducted by the **British Iron & Steel Institute** indicate that Sherardized coatings have a high resistance to corrosion by sea-water.[21]

★ ★ ★

Metal Spraying

A SWISS Engineer, **Dr. U. M. Schoop,** after investigating the effect of impact of lead bullets on steel plates, developed a method of metal spraying which employed a stream of molten metal conveyed by compressed air and forced through a suitable nozzle. The apparatus, as originally developed, however, weighed more than a ton, admittedly a somewhat unwieldy shop equipment, and the process was not utilized until metal in the form of wire took the place of the molten metal bath. One type of metal spray "gun" employed is shown in Fig. 5.

★ ★ ★

THE spray pistol can spray metals with melting points below 1600°C. (2912°F.), and the resulting coating has a characteristic layer effect which will be noted in the microphotograph at Fig. 6.

★ ★ ★

AN interesting example[22] of the use of this device in zinc-spraying is the behaviour of zinc sprayed lifeboats built in 1937 for the Orient Liner S.S. Oreades. The lifeboats were in service until the vessel was sunk by enemy action in 1943. The boats were picked up from two to ten months later in the South Atlantic, many having drifted half-submerged. On being returned to England, the boats were found to be in such excellent condition that it was found possible to return them to service.

★ ★ ★

CATHODIC metals such as Brass, Bronze, Nickel, Stainless Steel and Copper may be sprayed readily, but these are of no value in thin coatings since the base is rapidly attacked through the porous coating. Sometimes an undercoating of sprayed tin is employed, followed by a cathodic metallic sprayed coating and then dipped in a wax to resist acids and chemicals.

★ ★ ★

ANODIC coatings of Aluminum, zinc or cadmium do not require complete sealing; Zinc, on small articles such as nuts and screws is satisfactory at as little as 0.001 inch coating. It is recommended that aluminum should not be sprayed less than 0.003 inches thick[23]. Aluminum coatings on steel are recommended for immersion in hot fresh water, particularly **hard** water. Zinc-sprayed coatings are not recommended in hot water above 125°F. In distilled water, spray coatings will give excellent results; Zinc sprayed coatings—like other zinc coatings—must not be used in distilled water.

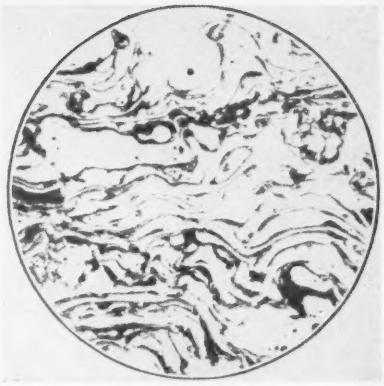

Fig. 6—Microphotograph illustrating the "layer effect" obtained by Metal Spraying. The Metal Sprayed in the particular case is Iron. * *

★ ★ ★

ALUMINUM and nickel-chromium spraying is particularly useful in treatment of equipment to withstand temperatures up to 1600°F.; the processes involving the use of these metals are covered by U. S. patents.[23]

★ ★ ★

Nickel, Copper and Chromium Plating

NICKEL, Copper and Chromium are cathodic metals, hence the protection afforded by such coatings depends to a great extent up-

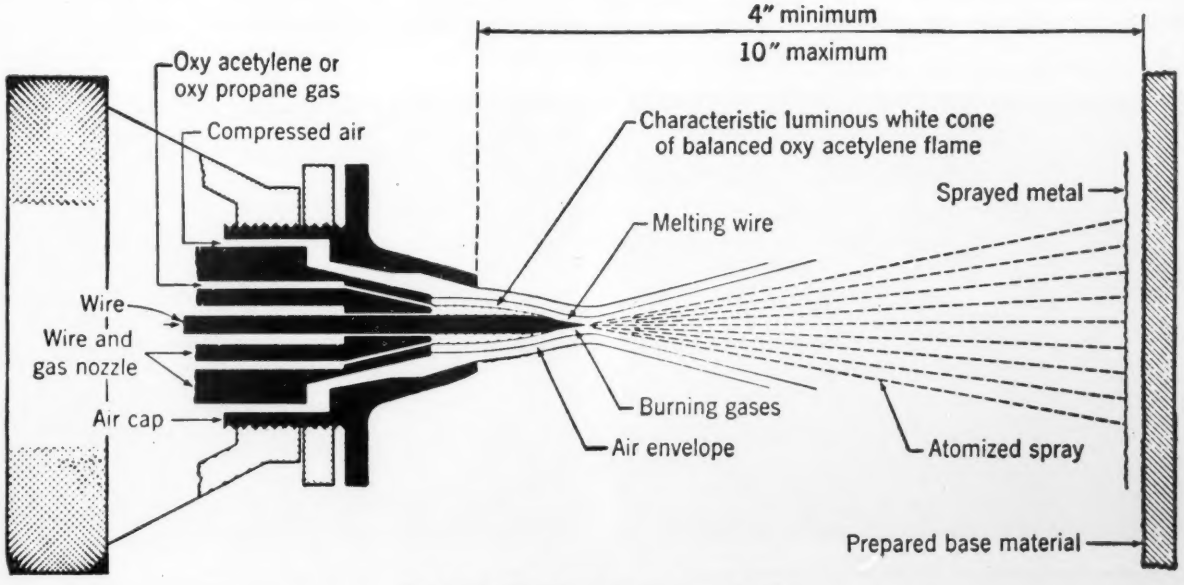

Fig. 5—Wire-Nozzle and Air Gal Cross Section as used in the Metco Metallizing Gun. * *

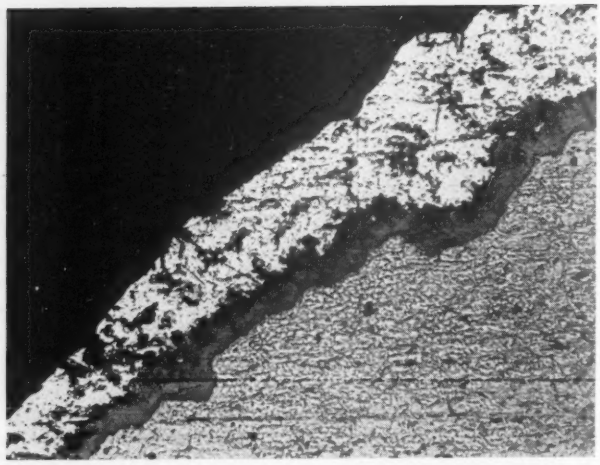

Fig. 7(a)—Hot-Dipped Aluminum Coating over Electro Galvanizing on Low Carbon Steel.

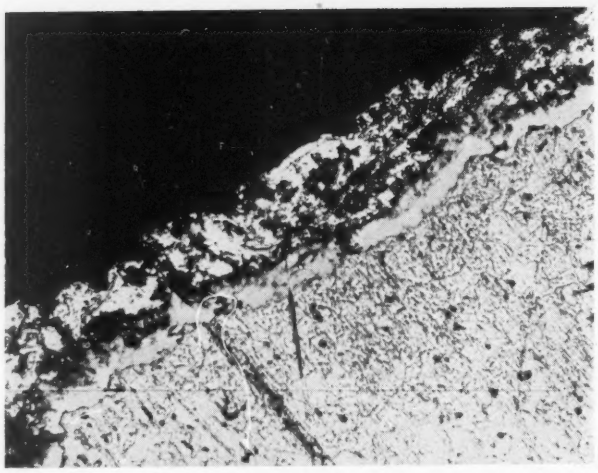

Fig. 7(b)—Hot-Dipped Aluminum Coating on Low Carbon Steel Coated Directly on Steel Base.

on their freedom from porosity. If plated to a substantial thickness with a continuous coating these metals (excepting copper as a clad finish) are suitable for limited outdoor use.

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NICKEL should be .001″ to .002″ thick for normal atmospheric exposure; for severe conditions 0.005″ to 0.006″ may be required. Discontinuities are present in commercial coatings less than 0.0015″ [24] thick, and upon exposure to corrosive environment additional porosity develops. Being cathodic metals no protection is afforded to the base metal. Tests carried out by the **National Bureau of Standards** indicate that the use of Cadmium or Zinc under Nickel causes a white stain and blistering without increasing the protective value of the coating.

★ ★ ★

CHROMIUM being much more expensive than nickel, and more difficult to polish, is generally applied in a thin layer over nickel as a non-tarnishing surfacing. At a chromium thickness of 0.0002″ internal stress causes fine hairlike cracks. As plating thickness increases, the plating covers over the cracks so formed. Chromium coatings of less than 0.0005″ in thickness are normally porous, and do not offer appreciable protection against atmospheric corrosion under severe conditions. One accepted chromium finish often used is 0.0001″ chromium, over 0.001″ of nickel. It appears [21] that thin coatings of chromium over cadmium tend to reduce the protective effect of the latter. Due to detrimental galvanic effects produced at discontinuities in chromium coating it appears that thin chromium over cadmium has less protective value than the zinc or cadmium alone. This is in accordance with the galvanic table and theory. [21]

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Kenmore Coatings

A NEW process developed by **Kenmore Metals Corps.**, details of which have been published in "Wire & Wire Products," shows

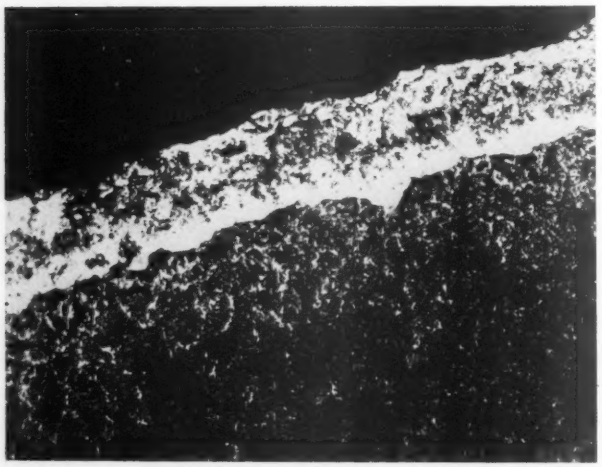

Fig. 7(c)—Hot-Dipped Aluminum Coating Directly on High Carbon Wire.

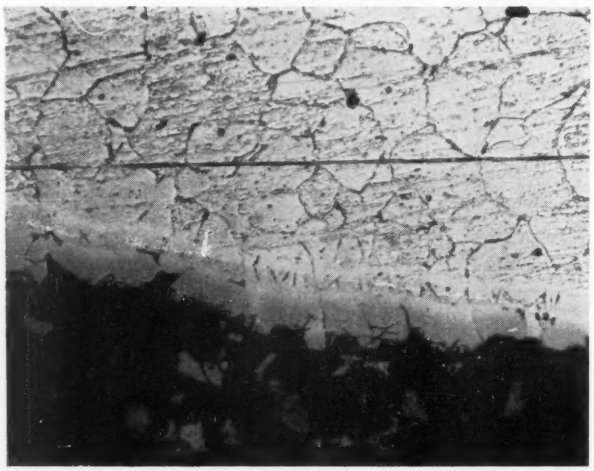

Fig. 7(d)—Hot-Dipped Aluminum Coating on Low Carbon Steel Wire, Retreated in Lead at 1500 deg. F. to Produce Iron Aluminide.

considerable promise as a method of plating steel with copper, nickel, zinc or chromium. This method is worth investigating as a process to be coupled with drawing after coating.

★ ★ ★

Cadmium Coatings

CADMIUM is generally applied by electrodeposition from cyanide solutions. It is not generally used for hot dipping steel, except in the eutectic composition (82.5% Cd) with zinc; copper may be hot dipped in cadmium in the unalloyed form. Cadmium and zinc are very similar in resistance to atmospheric corrosion.

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Tin-Zinc Coatings[25]

AS a substitute for cadmium, the **Tin Research Institute** in England developed, during the last War, a new electrolytic Tin-Zinc alloy containing 80% Tin and 20% Zinc. This coating, designed for use in severe tropical corrosion conditions, was found to be superior to a similar single metal thickness of tin, zinc, or cadmium; moreover the coating possesses excellent solderability—a fact which is of interest to the radio and electrical manufacturing industry.

★ ★ ★

Aluminum Coatings

IN the 1941 **Mordica Lecture,** our good friend, **Mr. Kenneth Lewis** said[26] "Keep your eye on Aluminum." Mr. Lewis pointed out, "Twelve cent aluminum which is just around the corner, is because of its bulk, equivalent to four cent zinc." Mr. Lewis' prophecy has not yet materialized in regard to price, but his foresight in regard to aluminum coating is rapidly materializing to fact.

★ ★ ★

MANY people have sought the "Philosopher's Stone" of a method of hot dipping aluminum and much has been published on the score on both sides of the Atlantic from time to time—**Dr. Colin Fink** described such a process involving hydrogen impregnation in 1933, and the **Iron & Steel Institute** in England,[27] in their Special Report No. 21, acknowledged that satisfactory adhesion could be obtained by first coating the steel with 0.0005 in. of electroplated zinc. Sheet samples so coated carried only 0.025 oz. of coating, yet after three years in the seawater spray test, no pits had yet penetrated the Aluminum coating.[27] In view of these tests the Corrosion Committee considered Aluminum-dipping as a process for which there would be a considerable future—provided that a process and fluxing operation could be developed to eliminate the preliminary electroplating. Many firms on this continent have carried on continuous research since the end of the war, and we can look forward to commercial production of aluminum coated wire in the near future.

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IN the present state, to the writer's knowledge, the high temperature of the process-aluminum melts at just over 1200°F. and dipping is carried out in excess of this temperature—limits the use of the process to low carbon wire, or to as-dipped tensile values not normally exceeding 150,000 pds. per sq. in. in ordinary carbon steels. This still leaves a reasonable market available to the lower tensile telephone wires, and may, because of the improved conductivity of aluminum, provide the first outlet of aluminum wire coatings.

★ ★ ★

THERE are many points which must be considered, however, before plunging into aluminum coating production. The high temperature of the process is one major factor which imposes many problems. The oxidation of Aluminum occurs at an amazing rate as has been ably pointed out by Mr. Lewis in his 1941 lecture. The resulting oxide quickly attaches itself to the passing wire even after a bond has been formed, and produces a "speckled" finish, or finally a rough finish as the film thickness grows. These oxides do not seem to reduce the corrosion resisting value of the coating, but they do seriously affect the appearance. Nor can redrawing, in every case, remove all roughness.

★ ★ ★

LET us examine Fig. 7 which shows microphotographs of several examples of Aluminum coatings. It will be noted that Aluminum over Zinc (Fig. 7A) as suggested, by the **British Iron & Steel Institute**[27] is effective, but the bond layer is essentially Iron-Zinc alloy. This is interesting, since it would appear that, while some Zinc is lost as the wire reaches the high temperature of the aluminum some of the former metal remains with the wire, alloys to form $FeZn_7$ and other alloys of the series, and finally is overcoated with Aluminum. It will be noted from Fig. 7 (b) and 7 (c) that the alloy-bond layer is much more definite when aluminum is coated directly on the steel.

★ ★ ★

NOW, let us examine the properties of these coatings. In order to obtain early results, tests were carried out in various media to obtain **relative** corrosion values in comparison with other normally used coating materials. Rapid testing methods involving muriatic acid and fumes were employed for comparative studies. The results indicated that we may expect longer life in chloride exposures if we employ straight Aluminum on Steel than with the alloy Zinc-Aluminum type coatings mentioned hitherto. Furthermore, these preliminary tests appear to indicate lower **thickness** losses for Aluminum than other "sacrificial" coatings. Atmospheric exposure tests of aluminum coatings have not been carried on by the writer for sufficient periods to permit true evaluations, but there is every indication that the losses are even lower than with zinc coatings.

★ ★ ★

ATMOSPHERIC corrosion tests[34] on Aluminum coated steel conducted over a four-year period in a mild industrial atmosphere have shown that aluminized (hot-

(*Please turn to page* 88)

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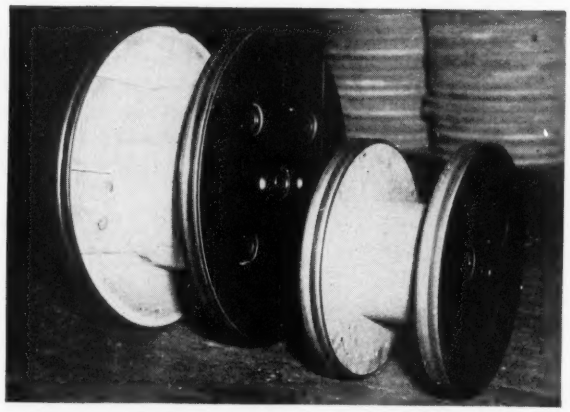

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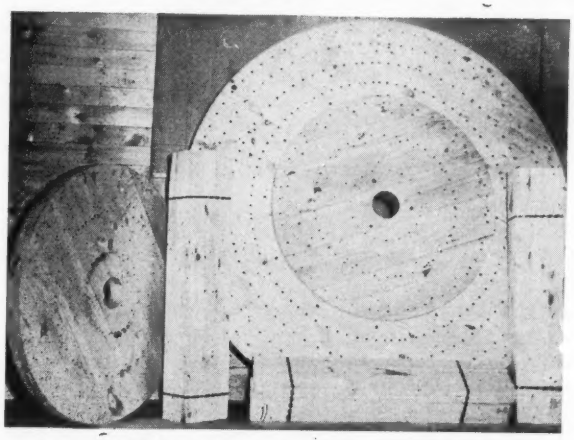

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XLN Magnet Wire Enamel

By Robert Lippe and Wallace G. Hope
Standard Varnish Works
Staten Island, N. Y.

The question space saving, better dielectric and higher heat-resistant qualities in magnet wire coatings is one that has occupied much time and effort in recent years. The work described in this article is one of the efforts in this direction that appears to have resulted in a constructive contribution to good magnet wire characteristics.

Introduction

THE age old problem of creating a midget with the muscles of a giant is one which constantly confronts manufacturers of electrical equipment. As this industry strives to confine more power into smaller generating and transmitting units, each piece of assembly, each unit of the whole assumes a new and greater importance. One of the immediate problems confronting the industry is the economical production of an insulated magnet wire enamel which will combine safety and dependability with all the mechanical and electrical requirements which make possible more compact finished units, incorporating greater efficiency than was heretofore available.

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AS early as 1939, significant steps in this direction were being taken. The polyvinyl-acetal-type coatings introduced at that time were considered a marked improvement over materials used previously. But during the twelve years this type of coating has been in use, its users have become increasingly aware of the high cost of special equipment attendant to its use.

★ ★ ★

SEVERAL years ago we started work on a project with the goal of developing a magnet wire enamel which could be applied by conventional coating towers, but would have properties comparable or superior to nylon or vinyl-acetal coatings. The result of this research is XLN, a synthetic polymer now being manufactured for use as a magnet wire enamel.

★ ★ ★

XLN is a linear polyester. Tests have proved that it is superior to materials used at present in the following:

1. XLN meets all national Electrical Manufacturers' Association tests for vinyl-acetal coatings.
2. It may be applied, without dies, in a conventional wire coating tower.
3. It retains its flexibility at 257°F. approximately 300% longer than nylon or vinyl-acetal materials.
4. It has higher abrasion resistance than acetal or nylon types.
5. It has outstanding solvent resistance.

★ ★ ★

Background

MAGNET wire is copper wire which has been specifically designed to be used in the manufacture of electromagnets. It is wound into coils, which become magnetic when current flows through them. The magnitude of the magnetic field depends upon the number of turns of wire in the coil and the amount of current passing through the wire. There must be no electrical contact between turns because any shorting would render the turns useless.

★ ★ ★

THUS, in any evaluation of a magnet wire enamel, the first point of consideration is that the enamel serves as insulation. The coating material must have certain electrical properties and maintain them for the duration of usage. Film continuity, high dielectric strength, good arcing resistance, and good insulation resistance are essential. Generally, only the first two are tested when checking magnet wires. The NEMA tests are designated MW 24-50C and MW 24-50A. The first, a continuity test, determines the number of breaks in the film per hundred feet of wire. The second measures the voltage needed to break down the film so that it will no longer be an insulator.

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SINCE the wires must be wound before they are used, their mechanical properties are considered carefully. If the film were to break due to any weakness, the value of the enamel would be lost because a film is effective only when it is continuous. Usually, for each broad property, some test has been devised to duplicate as nearly as possible field conditions. Complete simulation, of course, is impossible and there are often discrepancies between laboratory tests and production results.

★ ★ ★

FLEXIBILITY and the ability to be elongated are necessary, because the wires are stretched, wound into coils and bent into many shapes. The degree-of-bend and tightness-of-winding varies but, as a means of checking acceptability, MW 24-20A was created. This consists of winding the wire around its own diameter. No cracks should develop. In MW 24-20B, the wire is stretched 20% and then wrapped around a mandrel three times its own diameter. Again there should be no cracks.

★ ★ ★

SURFACE hardness, toughness and adhesion are combined and called abrasion resistance, in test

MW 24-25. The purpose of this is to determine whether or not the film will withstand the scraping and scuffing it must encounter when being wound. This too, is an arbitrary test. A special unit is used to measure this property quantitatively. It is composed of a needle weighted down by a known weight, moving across the wire. The number of scrapes needed to break through the film provides a means of comparing various enamels and a method of determining whether the material being tested meets the standards established by NEMA.

★ ★ ★

THE retention of the mechanical strength when the wire is subjected to elevated temperatures is very important because

1. **The coils into which the wire is wound are usually dipped into varnish and baked at about 275-340°F.**
2. **The units where the coils are used often run hot.**

★ ★ ★

TO test this property, specifications MW 24-30 and MW 24-35 are followed: The first is called "heat shock" since the wire is wrapped around its own diameter and then placed in an oven at 257° F. No cracks should develop within one hour. MW 24-35 is known as the "heat aging test." A sample of un-bent wire is kept in an oven at 257°F. for seven days, and then wrapped around three times its own diameter. A satisfactory wire is one which shows no visible changes after this treatment. Because it was felt that seven days was purely an arbitrary period, we continued the test for several weeks, with the result that the acetal coating failed after nine days while the XLN was good for about twenty-one days. This is an important gain in that it makes possible a longer useful life for magnet wires coated with XLN.

★ ★ ★

THE final tests deal with solvent, moisture, and chemical resistance. Various solvents and combinations of them are allowed to attack the enamel which, to be satisfactory, should not soften and should remain non-conducting. The reason for specifying such qualities is that there will be occasions when the wire will come into contact with these materials. An obvious example would be the case of impregnating the coils with a varnish. Here, wire enamel must resist the solvents which are present in the varnish. Moisture of all sorts is ever-present so that the film must not be affected by it. All the tests and measurements mentioned here have been carried out on wires coated with XLN, and in every case their results were satisfactory. The actual experiments and data are given under the section called "Experimental Data."

★ ★ ★

IT would seem that many of the tests were devised with a vinyl-acetal coating in mind, and certainly this would be true for standards established. With the advent of new materials, and the consequent incorporation of improved properties, it may be necessary to make some of the tests more rigid.

★ ★ ★

AMONG the various contemporary methods of insulating turns of coils are the following:

A. **Cotton coverings, such as uniformly wrapped fine cotton thread.**
B. **Silk and fibreglass coverings.**
C. **Paper coatings, in which a thin special paper is uniformly wrapped with a slight overlap.**
D. **Cambric braids either woven to the wire or slipped on in short lengths.**
E. **Plastic tubing extruded over the wire.**
F. **Wire enamels such as oleoresinous, vinyl, and XLN discussed in this article.**

★ ★ ★

THE wire enamels used since the introduction of electric motors and generators were generally a varnish type, made of tung oil and rosin in hydrocarbon solvents applied by a continuous dip process. By varying the degree of bake, the properties of the finished film could be regulated to meet customer requirements. The harder bake meant greater chemical resistance and higher abrasion resistance but with a sacrifice of flexibility and heat stability. Abrasion resistance of these varnish types was low, necessitating the use of fibrous coatings over the enamels when the wires were to be made into motor windings.

★ ★ ★

THE technological developments of the past fifty years demanded more efficient electrical equipment in the sense of greater output from small units. To do this, more effective insulation was needed in order to permit the winding of additional turns in a fixed space. The problem was solved by the introduction of the acetal-type of enamel in 1939. This combined all the desirable properties of the older enamels and added greatly improved heat-aging, much greater chemical resistance, and higher abrasion resistance. The acetal-type of coating was very satisfactory for many applications but had some distinctly undesirable characteristics pertaining particularly to **methods of application** and **heat stability.**

★ ★ ★

Application

PRIOR to the introduction of vinyl-acetal enamels, the custommary method of applying varnishes was a simple dip or flow on. The wire passed through a tank of varnish, picked up a certain amount of the solution and as it passed into a heated tower, the excess flowed back into the tank. Film thickness was controlled by varying the speed at which the wire moved and by regulating the viscosity of the varnish.

★ ★ ★

IN order to apply a nylon or acetal coating, a new method had to be invented, since, at usable concentrations, vinyl solutions are extremely viscous. This is inherent in all vinyl-type polymers, and results from the very nature of the compounds. If viscous solutions were used in a straight dip method, the resultant film would be too heavy. To overcome this difficulty, dies are used to wipe the excess coating from the wire. In order to maintain control of film thickness and ensure the centering of the wire in the die, each die has to be accurately machined and reamed, free floating on guide pins. To further complicate matters and

servicing and reconditioning of the applicator dies generally requires a separate department within the plant. This department must be stocked with expensive precision equipment and manned by specially trained personnel. Since whole sets of dies must be replaced every few days the overhead expense entailed by the supplementary operation is large . . . and hard to justify in a tight production budget.

★ ★ ★

THE new material, XLN, requiring no applicator dies, may be applied in a conventional varnish tower. It shows unusual tolerances in speed-of-run. Since any tower control system depends upon temperature regulation, change of draft, and humidity, it is impossible to bake every mile of wire to exactly the same degree. The uniformity of the film depends on the enamel, the design of the tower, and operating conditions. Wire coaters using the new XLN enamel may be confident that their production will pass specifications. Comparable results were obtained despite variations of from 8 to 13 feet per minute. Film thickness is regulated by varying the viscosity and concentration of the solution. The speed-of-bake is almost identical with that of high-viscosity, low solids enamels. It is thus possible for the coating companies to take advantage of the full capacity of their towers . . . at three times the coating speed used for oleoresinous coatings, and produce a finished film that has electrical, mechanical, and chemical properties never available heretofore.

★ ★ ★

Chemistry

XLN is a linear polyester, formed by esterfying various dibasic acids with alcohols, and dibasic alcohols. It is not modified by any extraneous resins such as melamine-formaldehyde, urea-formaldehyde, pheno-formaldehyde vinyls, etc. The degree of esterification and type of raw materials used depends upon the end properties sought. When baked, the polyester converts to a thermoset state by further esterification and through cross linking at points of unsaturation in the polymeric chains. It is believed that some of the cross links are due to primary bonds while others may be caused by secondary bonding. By varying the number of these and the distances between them, it was possible to regulate flexibility, toughness, and hardness.

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IT follows from this, that there are many possibilities of improvements and that the material can be formulated to meet specific requirements.

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THE viscosity of the solutions of XLN is relatively low, being approximately 1 cp at 50% solids. The reason for this phenomenon is that the molecular weight is small compared to highly polymerized materials such as polystyrene, and much of the size of the molecule is due to the secondary bonding, previously mentioned, which breaks down in solution. The viscosity may of course, be adjusted readily by adding thinner or leaving it out.

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THE chemical advantages of XLN, over conventional materials, may be tabulated as follows:

1. **Better product control may be maintained since the molecular size produced is small, and the end point of the manufacturing reaction is readily determined.**
2. **Since it is a polyester and not a vinyl-type polymer, there is no wide molecular size distribution. This also makes for uniformity of product.**
3. **The cured coating is a thermoset type resin so that it will not soften on further reheating.**
4. **The polar nature of the polyester causes it to be relatively insoluble in organic solvents and enhances its adhesion.**
5. **The absence of natural oils, used in varnish-type enamels, eliminates the possibility of variations due**

TABLE 1 — NEMA TESTS

TEST	COMMON NAME	XLN	VINYL-ACETAL	NYLON	OLEORESINOUS
MW-24-20	Own diameter bend	No cracks	No cracks	No cracks	No cracks
	(a) 20% stretch 3X diameter bend	"	"	"	Many fine cracks
	(b) Stretched to breaking point	"	"	"	Many fine cracks
	(c) Stretched to breaking point and bent around own diameter	"	"	"	Cracked
MW-24-24	Abrasion (Scrapes per mil)	70	59	20	27
MW-24-30	Heat-Shock 1 hr. @ 257°F.	No cracks	No cracks	No cracks	Badly cracked
MW-24-35	Heat-Aging days @ 257°F.	21	9	7	27
MW-24-50	Twist Dielectric Volts/mil	2000	925	1380	2080
MW-24-40	Solubility				
	VM&P Naphtha	Unaffected	Unaffected	Unaffected	Scrapes Off
	Toluol	"	"	"	"
	Denatured Alcohol	"	"	"	"
	5% Sulfuric Acid	"	"	"	Unaffected
	1% KOH	"	"	"	"
	30% - 70% TOLUOL Alcohol	"	"	"	Scrapes Off
MW-24-45					

to crop and seasonal effects. This also means that once the film is cured, it will not oxidize further.

6. Heat does not cause distillation of the monomer as is common in vinyl.

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Experimental Data

THE experimental work described was carried out in the Physical Testing Laboratory of the Standard Varnish Works. A tower was built according to plans designed to duplicate industrial towers as closely as possible. It is heated by electrical resistance units of ample capacity, controlled by a 2 KW Powerstat. The tank for the enamel holds about a pint of liquid. Baking temperature at the hottest spot is maintained at approximately 700°F. With this set-up, wire sizes from #17 through #30 A.W.G. were processed.

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FOR comparative test results, samples of XLN-covered wire were prepared by running #19 wire in this tower. The other samples were purchased in the open market and reflect average properties. All tests were conducted in our laboratory using techniques and equipment specified by NEMA.

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THE results obtained are summarized in Table 1.

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IN order to further demonstrate the results of the tests, the accompanying microphotographs were taken.

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FROM these, Figures 1, 2, 3, 4, it can be seen that heat-shock is equivalent for XLN, acetal, and nylon, whereas the oleoresinous is much inferior in this property.

★ ★ ★

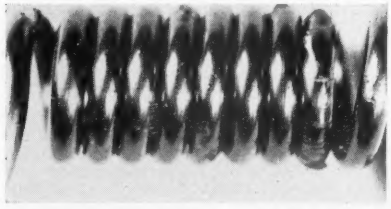

Figure 6—Heat ageing on vinyl acetal. There were cracks and blisters on several turns. This sample was fourteen days at heat. Some specimens showed identical results in nine days. *

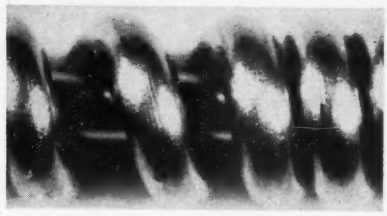

Figure 1—Heat shock on XLN. There were no cracks at magnification of 60x. * * *

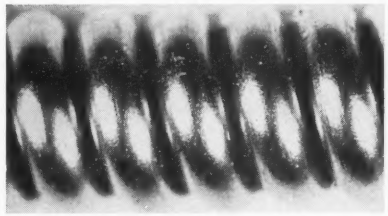

Figure 2—Heat shock on vinyl acetal. No cracks formed, although there seem to be several areas of discontinuity in the film. * * *

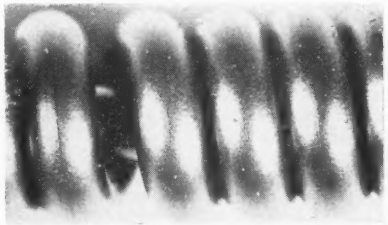

Figure 3—Heat shock on nylon. There are no cracks to be seen at the same magnification. Surface is not as smooth as the others. *

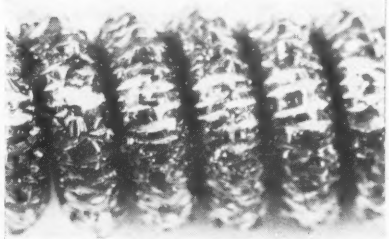

Figure 4—Heat shock on oleo resinous. The sample has cracked badly. Only 10 minutes at 257°F was needed to reach this state. *

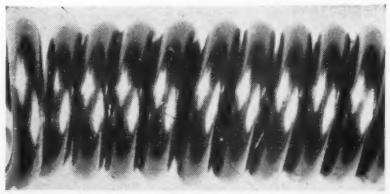

Figure 5—Heat ageing on XLN. Sample at 14 days showed no cracks. * * * *

THE heat-aging photos, Figures 5, 6, 7, show that XLN retains its flexibility for approximately 300% longer than the others.

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TABLE II

SOLVENT TESTS . . . Hours of immersion before XLN can be removed by one scrape.

	HOURS OF IMMERSION
	More than 96 hours
A. SOLVENTS	
1. Mineral Spirits	"
*2. SBP 3	"
**3. SBP 6	"
4. VM&P Naphtha	"
5. Coal Tar Naphtha	"
6. Xylol	"
7. Toluol	"
8. Benzol	"
9. Butyl Acetate	More than 26 hours
10. Butyl Alcohol	More than 96 hours
11. 5% H_2SO_4	"
B. VARNISHES	
1. 15 gals.—oleoresinous (Linseed Oil, Ester Gum)	"
2. 21.5 gals.—Tung Oil (100% Phenolic Resin)	"
3. 2 gals.—Linseed-Pitch	"
4. Drying oil modified alkyd + Urea—formaldehyde	"
5. Shellac	"
6. Non-drying oil modified alkyd + Urea—formaldehyde	"
7. Unesterified modified phenolic	"

* SBP 3 . . . A petroleum fraction, principally aliphatic hydrocarbon, but contains 10% aromatics. Boils at 100°-120°C.

** SBP 6 . . . Similar to SBP 3, but boils at 140°-240°C.

(*Please turn to page 93*)

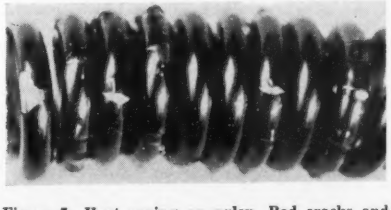

Figure 7—Heat ageing on nylon. Bad cracks and poor adhesion are apparent, although the sample was at heat only seven days. * * *

WIRE ASSOCIATION PROCEEDINGS

Discussions of Papers Presented at the Wire Association Annual Convention

Chicago, Ill., October 17-21, 1949

MONDAY, OCTOBER 17 Morning Session—11 A. M.	A. F. Anjeskey Sales Manager Chairman of Meeting	Cleveland Tramrail Div. Cleveland Crane & Eng. Co. Wickliffe, O.
PAPER: "Planning for Wire Mill Handling"	F. L. Hayden Works Manager	Steel Company of Canada Hamilton, Ont., Canada
PAPER: "Possibilities in Handling Wire & Wire Products"	J. W. Galloway Chief Engineer	B. Greening Wire Co., Ltd. Hamilton, Ont., Canada

The Technical Meeting of the 1949 Annual Convention of the Wire Association convened at eleven o'clock, in the Illinois Room of the LaSalle Hotel, Chicago, Illinois, Mr. A. F. Anjeskey, Chairman, presiding.

Mr. A. E. Glen (Carboloy Company, Inc., Detroit, Michigan): Welcome to the Annual Convention of the Wire Association for 1949.

Mr. A. F. Anjeskey, Sales Manager of the Cleveland Crane and Engineering Company of Wickliffe, Ohio, is Chairman of this morning's meeting.

Mr. Anjeskey. (Applause)

Chairman Anjeskey: Our first paper to be presented by Mr. F. L. Hayden, Works Manager of Steel Company of Canada, Hamilton, Ontario, Canada, is "Handling Wire and Wire Products in the Mill."

Mr. Hayden. (Applause)

. . . Mr. F. L. Hayden presented his prepared paper on "Handling Wire and Wire Products in the Mill" . . . (Applause)

Chairman Anjesky: Thank you, Mr. Hayden, for that fine paper.

Mr. J. W. Galloway, Chief Engineer, B. Greening Wire Company, Ltd., Hamilton, Ontario, Canada, will present his paper on "Possibilities in Handling Wire and Wire Products," and we will follow the two papers with a question period, and we will then have an opportunity to discuss them.

. . . Mr. J. W. Galloway presented his prepared paper, "Possibilities in Handling Wire and Wire Products" . . . (Applause)

Mr. Anjeskey: It seems to me the speaker has thrown a challenge to the wire equipment manufacturers. Any questions?

A Member: Have you an answer to larger bundles or "packages"?

A Member: It's going up.

Mr. Anjeskey: Mr. Beaman, Morgan Construction, what have you to say?

Mr. Beaman: Same answer. They are going up all the time.

Mr. Anjeskey: Any other questions? I don't want to bring this up as a plug but the remark by the speaker about the new method of storing rods, is interesting. I'd like to call on Mr. Hill.

Mr. Hill: Well, we are stacking rods vertically in approximately ten ton columns. That is 20,000 pounds. How much does that figure per square foot? In addition, sizes, heats, and alloys are separated.

Mr. Anjeskey: About 1250 pounds of rod per square foot of effective storage area.

Mr. Hill: We have also anticipated the elimination of two men in our rod shed due to this new method of handling material. You know more about it than we do.

Mr. Anjeskey: To give you some idea of capacity, the old method of storing rods horizontally, also maintaining size, heat and alloy separation permitted storage of about 350 pounds per square ft. of effective storage area. With solid piling and no size, heat or alloy separation storage up to about 650 pounds per sq. ft of area has been obtained with height of piles approximately 22 feet.

Vertical storage to a height of 22 ft. as Mr. Hill has stated, has accomplished two things. Greater storage per sq. ft. (1250#) and, what is more important, separation of size, heat and alloys.

This has resulted in lower handling cost (Mr. Hill states requires 2 fewer men) because re-handling is eliminated also keeping an accurate inventory of rod in storage, as each storage space or column can be designated with an identifying number on an inventory sheet and unit loads can be added or deducted from the particular storage area or column.

From a total cost standpoint, due to the tremendous increase in storage capacity, considering that less building area is required, also less steel for binning, the overall cost should be at least 15% less than by a horizontal storage system. The actual labor cost of handling should also be reduced considerably.

Any other questions?

A Member: I have not had an opportunity to study the published paper and I hope I may be forgiven if I ask a question which has already been dealt with in the paper, but could we have some information as to the amount of the overall cost of handling material; for example, if we look at an ordinary wire nail with a proportion of the total cost of that nail as represented in the handling of the material from beginning to end.

Mr. Anjeskey: Does anybody have an answer to that question?

Well, the statement has been made that making is ninety per cent moving. It is true in some industries. I don't know about the wire industry. Everything you touch has to be moved.

Is there any answer?

Mr. Galloway: I would say it is well over fifty per cent. I can't give any answer in dollars and cents.

A Member: In answer to his question, I believe it would be a simple formula. Of course, everybody deals their cost differently. Take your operator cost and then take your handling time and reduce it per pounds per man hour and everybody knows what their rates are. It is a simple formula to be worked out and I believe that these papers that were presented this morning have opened up something that is costing us a lot of money. That is, not the operators' cost but the handling; and if you attack it per pounds per man hour in breaking it down I think you can get a very quick answer. It would be fine if you could get it recapped from the different companies. You would see a lot of figures.

Mr. Anjeskey: I have seen some figures on handling rods and also cleaning rods and in investigating these figures instead of talking about dollars and cents have computed costs man minutes. It costs eleven man minutes to clean a ton of rods and seven minutes to handle a ton of rods.

In our contacts we usually talk about man hours or man minutes costs.

Any other questions?

A Member: Mr. Hayden, I can appreciate the fact that most of the men here are from the steel industry and use multiple drawing machines, but we are confronted with single block drawing. I'd like to know if Mr. Hayden uses single wire blocks. Does he use the Flipper type payoff on those blocks?

Mr. Hayden: We use practically no single blocks at all. They are all continuous.

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A Member: I don't understand the question, except how is it moved from one place to another. Now, we have single blocks for our very large sizes. Of course, that is all handled by overhead cranes and there we do no welding. There is one man with an overhead crane and he can handle a large amount of wire.

When we come to fine rods it is mostly handled on continuous wire drawing machines.

Mr. Anjeskey: Anybody else?

A Member: I think these two papers have opened up a subject that is pretty much in the heart of all of us and I am disappointed that there isn't more talking about it. I'm getting up and hoping that somebody else will get up after and say some more on the subject.

Our company is very much interested in what it can do to reduce its handling cost by increasing the package size. Our company as represented here has already increased its package size considerably. We have been considering whether we should go to 1200 pounds, for as we get up to higher wire drawing speeds the weight goes down; and we are just wondering if we shouldn't get the spools right away without going through this intermediate stage without increasing it.

We have a machine that I am going to describe this afternoon that is now having a spooler installed on it that will handle 2000 pounds and a 4000 pound spool. That is just a starter with us. We really don't know what we are going to do with it finally; but we are going to try using a spool, and I would very much like it if somebody else would get up and would talk about what they have done with spools and what success they have had with them. I think it is something that would interest all of us, and I hope someone will talk about it before we close.

Mr. Galloway: I spoke about the entire method on the back of the wire machines, putting in spools there of 700 pounds. We have found where we put in a 700 pound coil back of those fine wire machines, the number of machines that one man can run has gone up two and a half times; which shows some of the savings that can be accomplished.

A Member: I'd like to ask if anybody has had experience with spooling wire, with the kind of spools they are using to put 1200 pounds on and if they are putting 1200 pounds or more, what the maintenance cost of those spools are. Do they break or hold up? What are they made out of? Wood or steel?

Mr. Galloway: I can speak only of those 700 pound spools. There is a standard construction. So far as our maintenance cost of them, it has been practically nil. I think that again is going to be a case of education with our operators. Are they going to take and run trucks into them or are they going to be educated that a piece of equipment has got to be handled and handled carefully. If we approach it from that angle, I don't see any reason at all why our spool life shouldn't be a matter of five to ten years; and as far as stiffness of the spools, we have run into no trouble on that end, of the flanges spreading. I think we have spools today that will take all the extensions. That has been pretty well proved by the copper people. The copper people are spooling practically all of their wire and in all stages all the way down, and I don't know of any case where they are having excessive spool costs.

Mr. Hill: Of course, we are only single holing but we are drawing 3500 pound spools and of welded construction and they have been in operation for twenty-five years, and are carried by fork truck up to the machine for further processing.

Mr. Galloway: I'd like to hear some expression of opinion about our trucks and the merits between gas and electric.

Mr. Anjeskey: Any remarks?

A Member: Maybe we can venture an expression on that. We started with electric trucks. Possibly we didn't get the right kind. We found they are entirely too slow travelling from one point to another, so we have standardized on gasoline trucks.

Mr. Anjeskey: Any other remarks? I might add something to the cost of trucks. I understand the gas truck sells for about one half to two thirds the price of an electric truck, and being an engine it has to be overhauled about every twelve months. At least that is the remark of electric truck people, and their cost is batteries and charging cost. The old rule was that the cost of operating an electric truck was equivalent to the wages paid the man. I don't know how it compares with the gas truck. At least, these are the remarks of the sellers of such kinds of equipment.

Anybody here in the truck business that might add something to that?

Mr. Anjeskey: Well, that being the case I suppose we'll close the meeting. The meeting is adjourned.

. . . The meeting was adjourned at twelve thirty o'clock . . .

MONDAY, OCTOBER 17

Afternoon Session—2 P. M.

	Curtis Voigtlander Supt. Wire Mill Chairman of Meeting	Union Wire Rope Corp. Kansas City, Mo.
PAPER: "Plastic Strain & Hysteresis in Drawn Steel Wire"	R. S. Brown Chief Metallurgist	Rylands Brothers, Ltd. Warrington, England
PAPER: "Back Pull Wire Drawing"	H. J. Godfrey Development Engineer and Dartrey Lewis Chief Development Engineer	John A. Roebling's Sons Co. Trenton, N. J.

"Plastic Strain & Hysteresis in Drawn Steel Wire"

By R. S. Brown

The Technical Meeting of the Wire Association reconvened at two o'clock, Mr. Curtis Voightlander, Chairman, presiding.

Mr. A. E. Glen (Carboloy Company, Inc., Detroit, Michigan): I wish to welcome those of you who were not here at this morning's session to the second session of the 1949 Wire Association Convention.

We are fortunate in having Mr. Curtis Voightlander, Superintendent of the wire mill of Union Wire Rope Corporation, Kansas City, as Chairman of this afternoon's meeting.

Mr. Voightlander. (Applause)

Chairman Voightlander: I think they chose me for Chairman of this meeting because I am interested very largely in rope wire and this is a sort of rope wire meeting this afternoon.

We are glad to welcome our English friends from across the other side of the water, Mr. R. S. Brown and the others who have come with him.

Mr. Brown will give the first paper on "Plastic Strain and Hysteresis in Drawn Steel Wire."

Mr. Brown. (Applause)

Mr. R. S. Brown (Rylands Brothers, Ltd., Warrington, England): Mr. Voightlander and Gentlemen: Before I commence this paper, I would like to say what a great pleasure it is to me to be able to come here today, and to meet you all and chat about all these things of mutual interest. I hope that the subject matter won't prove too boring, and when I have finished presenting this paper, I hope you will all join in on a discussion because, I believe, it is a subject that needs opening up, and it is one in which we have to make some progress within the next few years if we are going to "knock" some sense into this question of testing wire in relation to its behavior or required performance in practice.

Now this paper was published at the request of the British Armour Research Association Wire Panel, which at its first meeting voiced a unanimous desire for a thorough examination of the methods of testing wire and that an attempt should be made to correlate those tests with actual service.

I think we will all agree that the tests we normally apply, the Tensile

Test, the Torsion Test and the Reverse Bend Test, while giving us something to go on to sell the product to the customer, never really tell us anything at all about how that wire is going to perform in a rope, whether superlatively good or ordinarily good, but we hope never badly as a rope.

. . . Mr. R. S. Brown presented his prepared paper on "Plastic Strain and Hysteresis in Drawn Steel Wire . . . (Applause)

Chairman Voightlander: Do we have any questions or other explanations?

A Member: What effect does carbon content or cold working hysteresis have on that plastic deformation; for instance, if we wanted a certain finish tensile, when we go to the fatigue circuit, what effect does carbon content or cold effect have upon it?

Mr. Brown: That is probably the most pertinent question that can be asked, because therein lies the control of this plastic property in wire. All the wire mill men know that you can take a 70 or 80 carbon and draw it 75 per cent and get 120 tons per square inch, or lower carbon and draw it 85 per cent or more and get the same tensile, but you won't get the same curves. You can also lead patent that wire and draw it not more than 70 per cent, or air patent the same carbon and draw it much more than 70 per cent. Those all produce different plastic hysteresis curves.

We believe it is better to use the high carbon, lead patent it and draw the wire less than has been hitherto adopted, rather than to use the good old-fashioned methods of air patenting with large grain and a large number of holes, 85 per cent, which gives magnificent torsions but very poor wire.

Mr. H. J. Godfrey (John A. Roebling's Sons Company): Mr. Brown has very graphically shown the effect of temperature during or after wire drawing, and his methods of testing.

To illustrate this point, I would like to present some slides. We endeavored to make some hysteresis curves.

. . . Mr. Godfrey presented slides accompanied by explanations . . .

Mr. Godfrey: In closing, I would like to congratulate Mr. Brown on his very fine paper. (Applause)

Chairman Voightlander: Is there any more discussion on this?

I think we should congratulate Mr. Godfrey on his rebuttal and added information on Torsion Tests of wire.

A Member: Do you feel that torsions mean anything in operation, when a wire is subsequently twisted, the formative twisting operation; I mean the twisting of cable wire?

Mr. Brown: It doesn't take on a permanent twist. I don't think it does. I agree, if that twist were applied as an alternating stress just in forming a cable, it would.

A Member: No, I mean in the case where you are forming a cable by a twisting means, instead of a stranding means, would torsion testing indicate anything as to performance. We have seen evidence that poor torsions give difficulty in twisting operations in forming cables.

Mr. Brown: There you have a particular case. Probably your experience is better than mine. I would have said "no", generally speaking. Let us understand what we mean by torsion tests. I am referring to the twisting of wire. Before it breaks it stands thirteen or more twists, but in a case, such as you are talking about, the wire wouldn't be twisted like that.

A Member: I don't see where the numerical torsions bear any relation to the behavior.

Chairman Voigtlander: Have we any more questions?

A Member: In that photograph that was shown of the splitting of torsions, which we have run into occasionally, have you been able to determine for any reason why you will find it more prevalent in some heats than in others, and also why you are finding it on one end of the coil and not on the other, drawn at the same speed and at relatively the same temperature?

Mr. Godfrey: As I inferred, split torsions are affected by the surface condition of the wire. You have heavier seams on one end than the other. That might show a difference from one end of the coil than the other. If the one end was drawn at hotter temperature than the front end, you might find it there.

A Member: I am talking about when it is free of surface defects and still you can create that condition?

Mr. Godfrey: I haven't seen any free of defects.

A Member: I am not satisfied that is from surface condition yet.

Mr. Godfrey: It is partially surface condition. It does not have to have seams. I have taken wire and ground off the surface and polished it to a mirror finish, and I have run a torsion test and gotten a smooth curve. I have taken the same type of sample with a mirror finish and heated it to 400 degrees and it has developed this crack; so you don't have to have a poor surface, it can be done with temperature alone.

A Member: I have found in the difference in heat it responds more.

Is there anything in inherent grain size? Does that have anything to do with it?

Mr. Godfrey: I don't know.

Mr. Brown: Might I suggest, if you carry out some stress strain cycle curves, you will get the answer to that. You do get characteristics in different heats which do accelerate strain age hardening. What they basically do, I don't think we know yet. The whole point in my paper is this: When a wire is freshly drawn and you don't disturb it by heating it or stressing repeatedly, then if you come to twisting it, as Mr. Godfrey has shown, it doesn't crack because the stress of the skin tends to rise to the breaking point and that capacity for enormous plastic stretch prevents breaking at the surface. If you raise and lower that stretch repeatedly and not just carry on with the torsion, your cyclic load would take care of it still and you wouldn't crack at the surface. But once you have heated that wire, you have lost your wide hysteresis and plastic stretch. When you start to stretch it, your skin goes to the maximum and beyond the breaking point and inevitably breaks and goes through to the center. That is it in a nutshell. It is the kernel of my whole paper.

A Member: Have you ever tried this sort of work with a banitic wire, rather than the pearlitic type of drawn wire?

Mr. Brown: Yes, I think over the years all our work has been directed to an examination of those variables of manufacture. The pearlitic wire is usually air patented and is fairly large grained. If you want to get any properties at all out of that, the wire patented in that way has to be drawn very heavily. Those do not give a good hysteresis and marked elasticity.

The deep lead patented wires don't need as much drawing. You have developed your tensile and inherent properties before you start to draw it. Those wires are the wires I have shown giving those greatly enhanced wire plastic properties, and those are wanting today and have been developed out of this background and knowledge of these tests.

A Member: At what temperature is that banite formed in heat treating?

Mr. Brown: Transforming it 500 centigrade. You multiply by 55, that is 932 degrees Fahrenheit.

A Member: Have you ever done it actually with banitic wire?

Mr. Brown: No, not that kind of banite. It takes too long to transport and we haven't any plan to do it. We have done small bits experimentally, but nothing to give reliable results; not that kind of banite.

Chairman Voigtlander: Is that all?

I think we need to thank Mr. Brown for a very interesting paper and also these gentlemen who participated in this discussion. I have learned a lot right here.

We will proceed to the next paper.

Thank you very much, Mr. Brown. (Applause)

Written Discussion of
Plastic Strain & Hysteresis in Drawn Steel Wire

by H. J. Godfrey, Development Engineer
John A. Roeblings Sons Co., Trenton, N. J.

MR. Brown has shown very conclusively the effect of temperature on the plastic properties of cold drawn steel wire. Of more importance, he has been able to correlate serviceability of wire

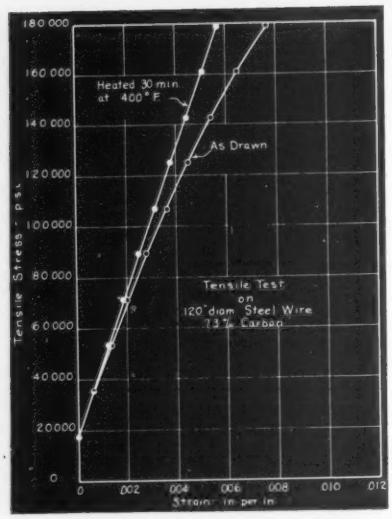

Fig. 1—Tensile Stress-Strain Curve.

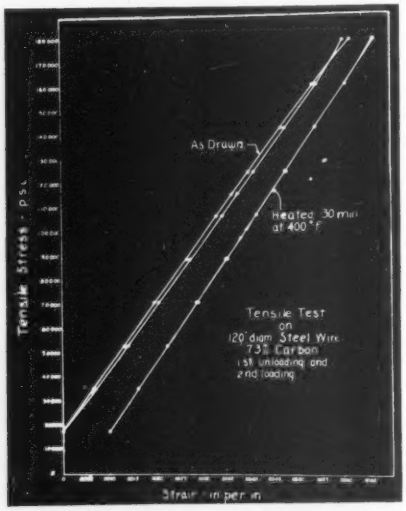
As Drawn
Heated 30 min. at 400° F
Tensile Test on 120" diam Steel Wire .73% Carbon 1st unloading and 2nd loading
Tensile Stress - p.s.i.
Strain - in per in

Fig. 2—Tensile Hysteresis Curve.

rope with the plastic properties of the wire. These plastic properties are seriously affected by high temperatures either during manufacture or following manufacture.

★ ★ ★

MR. Brown's method of studying the plastic properties of cold drawn wire requires accurate instrumentation and is time consuming. For these reasons it is not applicable to regular mill testing.

★ ★ ★

WE have also studied the effect of temperature on the various physical properties of cold drawn wire and have found that the torsion test has been very instructive. The plastic torsional properties of wire are readily observed from an autographic stress-strain curve made on a torsion testing machine.

★ ★ ★

THE results of a study of the effect of heat on the properties of wire are presented here. The physical properties of the wire before and after heating at 400°F. for ½ hour were as follows:

THE autographic torsion curve on the heated wire is very irregular after approximately one twist in an 8 inch gage length. This irregularity is caused by the wire splitting longitudinally and reducing its torsional resistance. The split usually progresses along the entire length of the test specimen before final fracture. This phenomenon occurs on wire which has been submitted to excessive temperature during manufacture, providing that the tensile strength is above certain strength levels which are dependent on the size and surface condition of the wire. The split type torsion fracture can be observed by the tester at the completion of the standard mill torsion test by observing visually the surface condition of the wire.

★ ★ ★

IN conclusion, I wish to congratulate Mr. Brown on his very fine paper which has shown that the plastic properties of cold drawn wire are directly related to the serviceability of wire rope.

★ ★ ★

Physical Properties of .120" Diameter Cold Drawn Steel Wire—.73% Carbon

Material	U.T.S. p.s.i.	Recov. Elong. in 10"-%	R.A. %	Torsions in 100 D	Type of Torsion Fracture
As Drawn	240,500	1.8	49.3	34	Transverse shear.
Heated @ 400°F. for ½ hour	259,000	1.8	46.9	27	Longitudinal split.

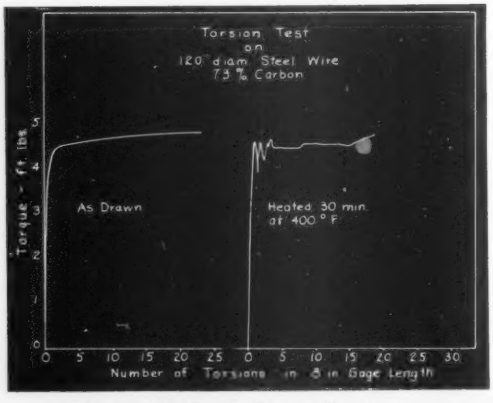
Torsion Test on 120" diam. Steel Wire .73% Carbon
As Drawn
Heated 30 min. at 400° F
Torque - ft. lbs.
Number of Torsions in 8 in. Gage Length

Fig. 3—Torsional Stress-Strain Curve (Autographic).

THE effect of heating on the plastic properties of the above material from tensile and torsion tests are illustrated in the accompanying illustrations:

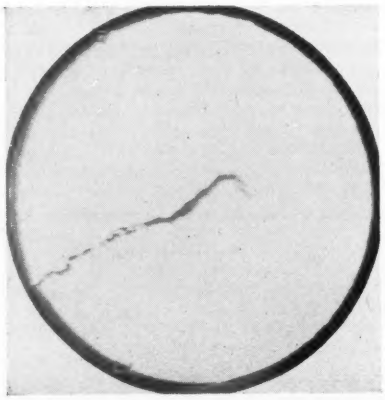

Fig. 4—Cross Section of Wire after Twisting.

Our next paper is the paper by Mr. Dartrey Lewis, of John A Roebling's Sons Company, on "Back Pull Wire Drawing," and the testing of an English machine which they have. Mr. Lewis will give this paper, rather than Mr. Godfrey.

Mr. Dartrey Lewis. (Applause)

Mr. Dartrey Lewis (John A. Roebling's Sons Company, Trenton, New Jersey): This is a joint paper presented by Mr. Godfrey and myself on "Back Pull Wire Drawing." It has been published and some of you may have read it.

However, we have some slides, and I will try to give the substance of it fairly briefly.

The subject of back pull wire drawing is not new to this audience. In fact, about ten years ago there was quite a flurry of activity. We had several papers from our members on the subject. Mr. Simons talked about some laboratory experiments he had made. Mr. Mueller talked about die friction in relation to back pull and Ken Lewis talked about die pulls in relation to back pull; and, of course, Mr. Stringfellow brought out this reactive wire drawing in which he geared the back pull to the front pull, so that it was a definite percentage of the front or forward pull.

The activity really started from work that was done by Professor Thompson in England. The most noteworthy thing he reported was by applying back pull in wire drawing, he could reduce the die pull to a point where it was low enough so he could push the die along the wire with his finger; and that suggested that perhaps we could draw wire mostly by pulling it, like you would in a tensile testing machine and have a very light die pressure, just enough to control the necking so you got a required diameter.

Not much more was done, or at least not much more was published, let's say, until about two years ago, when in England the Marshall Richards Company produced a back pull continuous wire drawing machine. This machine operated so you could control the amount of back pull applied. About a year ago the John A. Roebling Sons Company installed one of those machines and this paper really is our report to you on what we have found out.

. . . Mr. Dartrey Lewis proceeded to present his prepared paper, "Back Pull Wire Drawing" . . .

Mr. Lewis: That is all I have to say, except that Mr. Godfrey and I stand ready to answer any questions if we can. (Applause)

Chairman Voigtlander: I surely want to thank Mr. Lewis for a very interesting discussion on something entirely new. I know we have quite a number of questions that the different ones would like to ask and we are ready now.

A Member: I would like to say that we concur with most of Mr. Lewis' finding on back pull. We have experimented on the other end of the scale, and we have drawn .006" wire with back pull; but where Mr. Lewis said with the wire he was drawing it didn't help him any and it was absolutely impractical, we have found that is true with the finer sizes because the back pull has to be put up so high that the forward pull causes it to break.

I would like to ask one question, though, on this split torsion. It appears to be a time and temperature function. How much is time and how much is temperature? Mr. Godfrey's tests were made by heating for 30 minutes. In your case, when you had a small amount of wire on the block, the time was very short. In the other case, when you had your block half filled with wire, your time was quite long. Which is more important, the reduction of temperature or the reduction of time at a temperature?

Mr. Lewis: To answer your last question first, it is primarily a temperature effect. You have to have a temperature, I would say, of over 400 degrees Fahrenheit before you get any effect. If you go considerably above that, then you can do it in a very short time, but you have to have the temperature primarily.

In connection with drawing fine wire, all of the usual machines for drawing fine wire do use back pull. The so-called "Slipping Capstan" machine has a back pull, and the amount of back pull is controlled by the number of wraps you put around the capstan. It is a low back pull. I can understand your difficulty of using a controlled back pull, because it is pretty difficult to control it when you get down to a very fine wire.

A Member: I would like to qualify that a little further, because you say those machines have a certain amount of back pull and that is quite true, but the amount of back pull they have is absolutely insignificant in lowering the die pull. In our tests on pretty hard drawn, down to about 90 per cent reduction area where we are making our tests, we would have to put up the back pull to 20 per cent of the tensile before we got any effect whatever from back pull. The curve was very sharp. We got no effect from back pull at all until we got up to 20 per cent back pull.

A Member: You work with carbide dies, no doubt?

Mr. Lewis: That is very interesting. We have done no work with diamond dies.

A Member: There is a marked difference. It is not as marked on diamond dies as carbide dies, or I am saying the effect is not as definite when using diamond dies as when using carbide dies. However, when you are using diamond dies, you can function at a high percentage of ultimate in the wire and still have a certain amount of breakage.

A Member: With diamond dies, the fact is that the initial die pull was higher than with carbide dies, and the amount of back pressure, which is the back tension which could be applied, was greater, but the breakage would occur with less back tension on carbide dies than it would on diamond dies. In other words, diamond dies had a higher natural die pull than carbide, and yet we would break on the carbide with lower forward pull, and there was one thing associated with that, which was the vibration in the wire entering the carbide die, and there was no wire entering the diamond die. It seemed as if the carbide die was a succession of breaking and letting loose, where the diamond die was smooth. It was very marked in the number of dies and never failed.

Mr. Lewis: That is very interesting.

A Member: First, my compliments to you, Mr. Lewis, for a very good explanation electrically and mechanically.

I would like to ask a question, if I may. I would think I understand exactly how the motors are connected. There is one question, however, that I don't quite follow, and let us presume that we don't have perfectly equivalent reductions per die. They are not all 24 per cent, but, as you mentioned, one might be 20 per cent and one might be 10 per cent. Obviously, then, the several motors are probably going at different speeds.

The man strings up the machine and adjusts with his field rheostat the proper torque, as you described, but he does this at a low speed, a threading speed. Then when he is already and accelerates, or after he has accelerated, he must stop quickly for safety or for the end of the coil. Have you observed any differences in die pressure at that time, back pull or forward pull?

Mr. Lewis: No, the way the thing works is this, that when you accelerate, you have to have some accelerating torque. In other words, you need more torque to bring the machine up to speed than you needed while you were drawing for threading, or you are going to need when you get up to speed. What happens? The armature current increases, due to taxing out of existence in the accelerating cycle, but it increases equally in all of the armatures, so you get a 10 per cent increase in torque on all of them and that starts them all accelerating together and the net result is that you can accelerate up to speed without getting any disproportion between the pulls of the different dies during acceleration.

A Member: However, the current that the motor has to draw, isn't that going to divide itself between what it takes for acceleration and what it takes for the difference between forward and back die pull? If they don't happen to match, won't that show a difference in die pressures? I was interested because it would appear as though without a perfect relationship the several motors with the same current going through them, but coming up to different speeds, would probably not require the same amount of current for acceleration, with the result that it may show up a different relationship between forward and back pull.

That may be insignificant, particularly if your back pull is in the lower order. It might be very undesirable if you were running at a high back pull.

Mr. Lewis: Theoretically you are cor-

(*Please turn to page* 74)

THURSDAY, OCTOBER 20

Morning Session—10:00 A. M.

	R. S. Simmons General Metallurgist Chairman of Meeting	Keystone Steel & Wire Co. Peoria, Ill.
PAPER: "Continuous Cleaning"	by D. L. Doty Supervisor—Inspection Div.	Jones & Laughlin Steel Corp. Aliquippa, Pa.
PAPER: "Processing of Stainless Steel Wire"	by S. P. Watkins Asst. to Gen. Mgr.	Armco Steel Corp. Baltimore, Md.
PAPER: "Welding in the Wire Industry"	J. H. Corson Metallurgist	John A. Roebling's Sons Co. Trenton, N. J.

"Continuous Cleaning"

By D. L. Doty

The Technical Meeting of the Wire Association reconvened at ten o'clock, **Mr. R. S. Simmons**, Keystone Steel and Wire Company, Chairman, presiding.

Mr. A. E. Glen: Gentlemen, we have rather a full meeting this morning, so I think we should get started.

I would like to introduce Mr. R. S. Simmons, Chief Metallurgist, Keystone Steel and Wire Company, who will be the chairman of your meeting this morning.

Chairman Simmons: The first paper this morning is going to be given by the Metallurgical supervisor of the Inspection Division of the Jones and Laughlin Steel Corporation. Previous to that he was Chief Inspector. He is a graduate of Penn State College, with a B.S. in Metallurgical Engineering. He is a graduate of the Aliquippa High School, and, in fact, he is an Aliquippa boy who made good in his own home town.

I think we will enjoy the first paper this morning. It is entitled "Continuous Cleaning."

Mr. D. L. Doty. (Applause)

. . . Mr. D. L. Doty presented his prepared paper entitled "Continuous Strand Cleaning and Coating of High Carbon Rods and Wire" . . . (Applause)

Chairman Simmons: I think Dave was rather brave to write a paper on such an experimental process. It is easy to describe a commercially available process but these experimental processes demand a great deal of fortitude as well as initiative. We now have had two papers on processes still in the experimental stages. After the excellent paper on "Back Pull" we all must grant that "Back Pull" decreases the pressure on a die, but we ask ourselves "so what?"

Well, the same with Dave's paper, we can clean in a strand operation. I guess most of you have cleaned in this manner. However, you say, "We still have our cleaning houses and we still have to pay the laborers." Although none of you can probably describe a process that is commercially in service now, we all would be interested in hearing about your experiments and plans, because as Ken Lewis said, discussing "back pull". "Maybe there is a future to this." Maybe there is a future for a different type of cleaning.

The meeting is open for discussion and we want you to tell just what you have done in strand cleaning.

A Member: Regarding the lime substitutes, I have done quite a bit of work in that direction. Regarding the coating of the strand the lime substitute, without lime, the time, from my experience, if the wire comes straight out and is dried immediately by hot air, is 15 seconds. You don't require three minutes for it. In fifteen seconds it will put on a heavier coating than you can get by dipping the coils in a tank. I have had that experience on high carbon wire, and this statement is pretty definite, I think, because we measured those coatings and that was all it required.

Chairman Simmons: That is fifteen seconds with your coating? Do you have to put anything over it?

A Member: No, nothing else is required. The wire has to come straight out, because if it comes out sideways you lose a lot of it. If it comes straight out and hot air hits it right away, it will dry in fifteen seconds. Of course, there is a drip down the wire. It doesn't dry right away when you run it through fast speed. Now the fifteen seconds time, I think, is when using a tank about four feet deep. I think that gives about the average speed, fifteen seconds, and you can put on a coat and run at the highest drawing speeds. I will say on Vaughn machines, six or seven drafts down to .037" wire in this particular case, and the measurements we have made on the coatings are greater than three minutes in a dip tank.

Chairman Simmons: What do you think of that, Dave?

Mr. Doty: Well, any lime substitute which can be applied in that short a time is naturally going to be very attractive. Regarding this paper, I realize that I stuck my neck out in a lot of cases, and I did not specifically name any particular products, because I don't know, I tried to generalize. Fifteen seconds, naturally, in any coating operation would certainly cut down the space required and become very attractive. That hasn't been our experience. We have tried a number of lime substitutes and have not been able to get a sufficient coating in that short length of time.

A Member: Mr. Chairman, all I want to do is ask what is meant by "the wire coming straight out"?

A Member: What I mean by that is when the strand comes along and goes down in the coating solution, it has to come vertically, straight up.

A Member: It has to rise vertically?

A Member: Yes, and the heating apparatus two feet higher than that, so that it catches it right away. I have been working on one system where it comes out sideways, and we notice that quite a lot of the solution drips off that way, but when it comes straight up it drips down the wire and as soon as it hits the heat all the water is evaporated and the coating remains on the surface of the wire. That is one of the most important things that I know of in the process of cleaning and coating.

Mr. Doty: Yes, I think that is correct in any of these coating operations. You would be much farther ahead to come out at right angles at the end of your coating tank.

Chairman Simmons: Are there any men present who manufacture equipment for brush or shot cleaning? It would be very interesting to know what possibility there is in mechanical cleaning? Is there anybody acquainted with this, or is there anybody who can enlighten us a little more on this subject?

A Member: Mr. Chairman, might I ask in this shot blasting, does that have a tendency to remove short seams and things like that?

Mr. Doty: There have been claims made that the action of the shot on the wire has what they term an upsetting effect and tends to break up the continuity of the surface defects. If that is true, it would certainly help toward improving general surface condition.

A Member: We have a metal phosphate coating with which some of you are familiar, and Dave, in his paper, stated in order for a phosphate coating to be successful you should be able to apply 140 milligrams in thirty seconds or less.

I might say at the Mid-Western plant, we apply more than 150 milligrams in less than thirty seconds and draw the line—I can't feel free to name the plant, but I will be glad to discuss it with any of you later.

A Member: Let me ask a question about these coatings and the time required to get a satisfactory product. I can understand that those which attach themselves by chemical action need a

definite time for it to take hold. How about those purely mechanical lime coatings, borax coatings and things of that sort? Is there any problem there whatever?

Mr. Doty: I think that you do have a time problem there, although on some of these that attach themselves by mechanical attachments, you might say, I believe you are probably able to do those in a shorter space of time, if you have that dragging out effect. I am not sure of that. We weren't able to get the job done in the shortest space that has been claimed.

A Member: I am thinking now—let's be specific—of a lime coat in batch pickling and I presume it is true right down the line. It is impossible to get wire in and out of the lime in such a way as to get a scanty or no lime coat. Now, why is there any time problem whatever? The lime is there. The emulsion is there. The wire goes into it and the lime clings to it. Of course I know that you can get a somewhat heavier lime coat by repeated dipping and drying and that sort of thing, but those very heavy lime coats are unusual and aren't they abnormal? Isn't the ordinary batch coated lime job a dip into the lime and out of the lime again?

Mr. Doty: It may be in some places. In some places I think it might require two or three dips.

A Member: And let's mention borax, most people require an emersion in there of at least a minute or a minute and a half. That is my impression, in order to get penetration.

A Member: But on that strand you don't have that condition? You get wetting almost immediately on emersion.

Mr. Doty: Definitely. The reason for differentiating between the two, we have been unable ourselves to draw successfully without lime, using those compounds which attach themselves mechanically.

A Member: You say you have, or have not?

Mr. Doty: We have not been too successful.

A Member: To be specific, if you will, what was your experience with the lime coat continuously applied?

Mr. Doty: We weren't able to do much good on lime coat alone continuously applied, because we got a lot of flaking through the abrasion of going over the shives.

A Member: Could you see any evidence of it in a longer emersion?

Mr. Doty: We tried that by backtracking through the solution a couple of times, but it didn't do much good. The base coat of a lime substitute, such as a phosphate, for example, seemed to give better adherence.

A Member: Regarding putting a lime coating on in continuous cleaning and coating, there is one thing that happens there that when the strand of wire comes out of the lime coating and hits the cold reel afterward, there is a strip all through the wire that is naked. It takes it off, whereas the other compounds don't flake at all. There is nothing loose on there. It just makes a hard surface coating all over the surface of the wire.

Now regarding the borax compounds, I believe I am the first man in the industry who ever started that, and when it comes to borax alone, of course, there is a possibility of some flaking there. Now different things have been added there. Some people have added a lot, I guess, in the way of wetting agents, which I personally believe are not the right thing.

We solved the problem with water soluble synthetic waxes, and that is the reason why a coating that is properly prepared, a borax base coating is going to hold that stuff right on the wire. I say borax because it is not hydroscopic and there has to be the proper alcohol in there as that carrying agent.

It can be done in fifteen seconds. That is why I mentioned that time and when it hits the cold reel, it doesn't strip the coating off. The coating is even all over, and as I mentioned you pick up in fifteen to twenty seconds more coating than you will by dipping the coil in the tank. I have done a lot of that work and have been watching it. It has been more of a hobby with me.

A Member: Most of the discussion so far has been on the coating. I would like to hear a little more about the cleaning. The cleaning is really a problem, because there you have chemical action and you have to allow time enough. Muriatic acid is good, but it is very objectionable because of the fumes. The temperatures which you mention are pretty high, so the fumes would be serious.

Has any one used sulphuric acid? If it could be used it would be much better. Has anyone used an electric current to assist with the cleaning?

Chairman Simmons: Do you know of any, Dave?

Mr. Doty: I know we haven't, and I don't know of anyone else who has used either an electrical current or sulphuric acid to clean. We would be very glad if they would speak up.

Chairman Simmons: I might say in our plant, we used hydrochloric acid and successfully cleaned and drew rope wire for patenting sizes larger than 13 gauge and made good rope wire out of it, but in the finer sizes we weren't able to get anywhere with strand cleaning.

A Member: I have used electrolytic means in a dilute sulphuric acid solution merely in an experimental way in a sort of semi-private plant and found the indications extremely gratifying. We never carried it any further. The cleaning seemed to be complete and extremely fast.

Chairman Simmons: Has any other mill played around with this thing? Somebody may be able to give us their experiences. We know it is still experimental, but the results might be interesting.

A Member: We have done some work on that. We have used sulphuric acid in electrolytic bath and have cleaned about within ten to fifteen seconds. We get no smut formation on high carbon wire. We run the acid bath at 120 degrees and it seems much more satisfactory than muriatic acid.

Chairman Simmons: I guess the allotted time is up for discussion on this paper, and we will go on with the next paper.

Thank you Dave, for your fine paper. (Applause)

"Processing of Stainless Steel Wire" — By S. P. Watkins

The next paper is to be given by the Assistant to the General Manager of the Baltimore Plant of the Armco Steel Corporation, Mr. S. P. Watkins, who will give us a discussion on "Processing of Stainless Steel Wire." You probably are all acquainted with Mr. Watkins. He was awarded the Wire Medal in 1949, I believe. At that time he was Manager of the Market Development, and that sounded like a pretty good job, now he has stepped up to Assistant to the General Superintendent. So every time he gives a paper, he seems to get a new job.

Mr. S. P. Watkins. (Applause)

. . . Mr. S. P. Watkins presented his prepared paper on "Processing of Stainless Steel Wire" . . . (Applause)

Chairman Simmons: Gentlemen, the meeting is yours. We don't draw stainless steel. We just fabricate it.

These stainless steel fellows come around and ask us whether they can't give us more stainless steel wire and we say "Get the price of it down and we might." Their answer to us is "You give us the tonnage if you want the price down."

Maybe Mr. Watkins can comment on that.

Mr. Watkins: All I can say is that I am not in the sales department.

A Member: I wonder if you could give me the ratio of the bearing length to the diameter of the wire?

Mr. Watkins: We don't have any definite figures on that. The only thing is by a rule, and I don't think we ever worked out any direct bearing ratio as to the size of the wire. In other words, we try to make it heavy enough to support the drawing force and still get it sufficient—make it as short as possible —to take that load, but we haven't worked out any definite ratio of the bearing length to the diameter of the wire. We try to keep it as short as we can to take that load, which has been gauged primarily by experience.

A Member: You said you used a 12 to 16 degree angle. Do you mean on the smaller sized wire you use the 12 degree angle?

Mr. Watkins: Yes, on the smaller size we use the smaller degree.

A Member: Is that on account of the lighter drafting?

Mr. Watkins: That's right.

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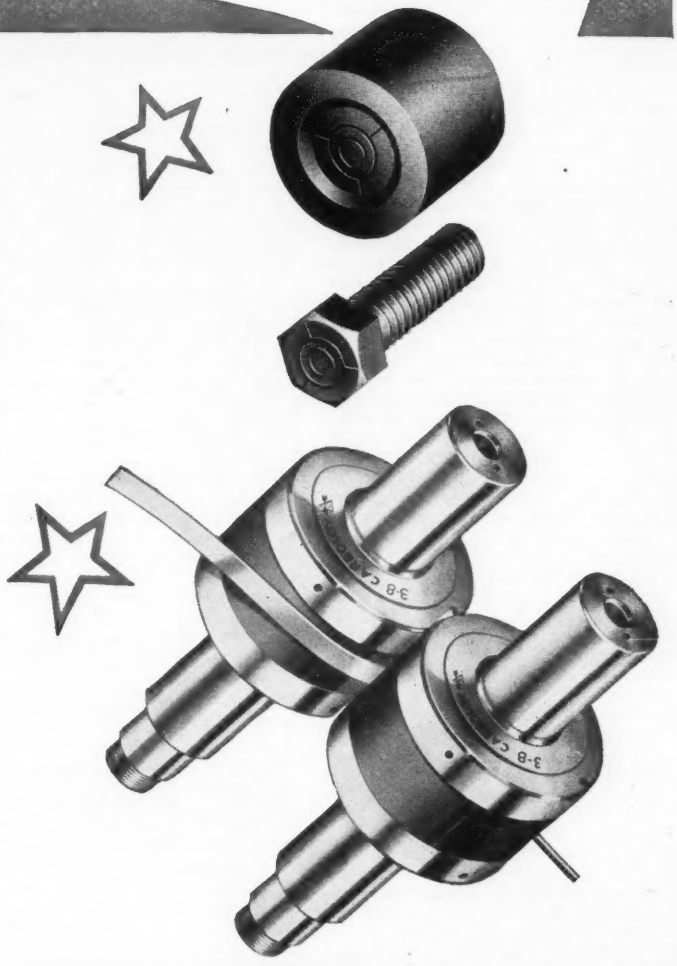

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*City*_____ *Zone*_____ *State*_____

A Member: That is something tnat I have been yelling about for a long time, that the angle of the die varies with the percentage of reduction and with nothing else on earth. I am glad to hear you confirm it.

A Member: I would like to ask a question. We are only fabricators of stainless steel, and in the past there has been some difficulty experienced in the manufacture of stainless steel rope, insofar that the ultimate breaking strength that we would like to achieve is not always reached, and at this time there is some attempt made to reduce these breaking strengths on your specifications. However, when we contact the stainless steel mills, we are given the advice to make the rope from the wire given and then bake this rope at a temperature of approximately 300 to 400 or even 450 degrees Fahrenheit for about three hours. My question is, therefore, does the stainless steel industry admit they have reached a limit in their tensile strength that can be achieved with the wire in our rope? Because if we go higher in the tensiles on the wire, we get a still lower efficiency. In other words, what I mean to say is this, if we can get a rope of wire about 300,000 pounds per square inch and make it into a rope, we might only get 75 per cent efficiency or 70 per cent efficiency. If we still go higher, we say 350,000 or 400,000 pounds per square inch, stainless steel wire, we get still smaller efficiencies. Therefore, we cannot go higher on our breaking strength. Could Mr. Watkins give us some information on that?

Mr. Watkins: What do you mean by efficiencies? I am not a rope man.

A Member: If we take a number of bars with an ultimate strength of 400,000 pounds per square inch and calculate these wires a number of times and, assuming we reach 20 tons or 10 tons—it doesn't matter—after this wire is stranded and closed into a rope, due to the stranding, we have a certain loss of tensile strength.

Mr. Watkins: That is true.

A Member: And we receive perhaps only 75 per cent of the aggregate strength of those wires or 70 per cent, and as we increase—at least that is what the stainless steel company tells us—the tensile strength of the wires per square inch, the efficiency becomes still smaller in the aggregate; and it has been recommended to bake the rope after fabrication in order to stress relieve these wires, as we are told.

Mr. Watkins: That is a perfectly sound recommendation as far as stainless steel is concerned. The only available material up to the present time for making rope, high tensile rope or spring wire out of stainless steel, in any sort of efficient fashion is the so-called chrome nickle types which save their high tensile strength by cold working. When you cold work these materials up to the range you speak of, up to 300,000 tensile, which is perfectly feasible, particularly with small wire which takes 90 per cent reduction to get that tensile strength, and you have to have the right analysis of 17 chrome and 17 nickle, although this material will have a tensile of around 300,000 pounds per square inch, its yield strength or elastic limit will be relatively low, maybe in the range of 300,000 P.S.I. It has been common practice, almost universal practice, of all people making springs out of high tensile to give a special treatment after the wires are formed in a range of 700 to 900 degrees Fahrenheit. I believe 750 is the customary range in which they treat it. This tends to bring up the elastic limit materially. In other words, the material has been drawn to 300,000 P.S.I. with a yield strength of 100,000. After this treatment, the yield strength will jump up to 200,000 or 250,000 P.S.I. and the tensile strength will not change materially. It may change a few thousand pounds per square inch.

Recently we have had in our department an alloy which is a precipitation type of stainless, which by combination of cold drawing, plus a 900 degree treatment you can get elastic and tensile properties which correspond very closely to so-called piano wire or well tempered carbon steel wire. We think this alloy has a lot of application properties in rope. We know it has wide application for making springs. We don't know about any of the properties for making rope, but we would like to discuss it with you at some later date.

A Member: I would like to ask if you had any experience or thought of using a Turk's head for finishing up that refrigerating wire, so you have a cold roll on it?

Mr. Watkins: Yes, we use a Turk's head in a lot of our forming operations.

A Member: Do you use it on the round wire?

Mr. Watkins: We may. Ordinarily we would use it, I think, after the round wire has been formed, you know, square or rectangular shaped; for instance, one of those shapes with a groove through the center. I think that was produced with a turk's head set up.

A Member: Is it possible by using a Turk's head at a 45 degree displacing angle to roll them around and keep away from the pin and maybe help you in your electropositive, and later on take a reduction on cold roll?

We use Turk's heads a great deal. We have them on quite a few of our machines in our cold rolling department. We use them extensively for forming various types and shapes in combination with the rolling.

A Member: I would like to congratulate the author on his very excellent paper on what I think is a very important subject. It must be clear to us all that the uses of stainless steel wire will grow enormously as the commercial cost is reduced, as I hope it will be.

My chief interest in commenting on this paper is because the drawing of this wire is essentially the drawing of a wire which is coated with metallic coating, and I think possibly an experience of my own in the drawing of metallically coated wire, although it was not stainless steel, may be of interest on this subject. I refer to the drawing of some high carbon steel, which had been galvanized before drawing, and it was possible by application of an amount of back pull to reduce the pressure on the die to about 50 per cent of what it would have been without back pull. The result of that was that it was possible to draw this material before we reached the point at which we damaged the coating to nearly double the speed at which it had been possible to draw this material before.

Now I should like to ask the author if it would be possible to draw stainless steel with the die pressure, that is the pressure on the walls of the die, reduced to about half of what he gets now? Would that throw a different light on the choice of lubricants? In other words, would it be possible to draw this material without the metallic coating, or would it, perhaps, be possible to draw it with some different metallic coating, which may possibly be easier to remove from the finished product?

Mr. Watkins: We recognize the limitations of drawing in lead, because, for one thing, we can't get an ironing of the surface if any sort of metallic lubricant is on there that you would get if you had a very light lubricant, such as grease. It is very desirable, as I pointed out, to try to draw a stainless with a light lubricant, or, in fact, none, if you possibly could get away with it, in order to iron out the surface and get a higher luster. When you put a metallic coating on there, if you have a few little lines or seams or pits and so forth, the metallic lubricant, or almost any lubricant, has a tendency to fill up these grooves or pits and they are not ironed out. In other words, the die doesn't get a chance to work on them, but for all practical purposes, for heavy roughing drafts, we haven't been able to find anything as good as lead. Although we know it has its drawbacks as far as surface is concerned, it is economical as far as speeds and drafts are concerned.

We have never tried to draw with zinc, although I understand there is some wire being produced in this country, stainless steel wire, with coating. I don't know what the application is, but I know it is being produced. Of course, tin is being put on stainless wire for soldering applications and copper for cold heading. We have never tried to take any heavy drafts on copper. We primarily use that for the final coating on stainless as far as cold heading purposes are concerned.

Chairman Simmons: What did you want to say, Kenneth? I guess we can stand making our lunch a little late.

A Member: As a matter of fact, I was just going to fill in what time there was left, but the question came to my mind in the last few minutes when Mr. Watkins mentioned drawing in zinc with a zinc coat. About twenty years ago, when stainless steel wire began to become a live issue, I started this consulting practice of mine, and, as you can readily imagine, I had a year or two in which I had practically nothing but leisure time. I spent a good deal of that leisure time experimenting with stainless steel, which I thought was a "comer." I tried to devise coatings, drawing coats, chiefly along the lines of trying to develop some corrosion product of the metal itself that would simulate our well-known sul coat.

I got several of them. None of my methods has found its way into commercial practice, but one was interesting along the lines that have been discussed in the last few minutes. I sealed up a coil with stainless steel wire in the steel pot, and I threw some printer's

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FRIDAY, OCTOBER 21

Morning Session—10:00 A. M.

	D. Boyd Metallurgist Chairman of Meeting	Wire & Cable Div. Northern Electric Co., Ltd. Montreal, P.Q., Canada
PAPER: "Spools for Shipping Magnet Wire"	F. A. Rappelyea Chief Engineer	Hubbard Spool Company Chicago, Ill.
PAPER: "Magnet Wire Plant— Fort Wayne Works—General Electric Co."	F. A. Arnold Metallurgist	General Electric Company Fort Wayne, Ind.

"Spools for Shipping Magnet Wire"

By F. A. Rappelyea

The Technical Meeting of The Wire Association reconvened at ten o'clock, **Mr. D. Boyd,** Metallurgist, Northern Electric Company, Ltd., Chairman, presiding.

President Seymour: We will come to order, gentlemen, and without further ado, I am going to turn the meeting over to our good friend, Mr. L. C. Whitney, and he will carry on from there. Thank you.

Mr. L. A. Whitney: Mr. President, Gentlemen: Our non-ferrous sessions, as you possibly know, will include a total of five papers. There will be two presented this morning and three this afternoon. They have endeavored, in accumulating these papers for presentation today, to have a rather diversified list of subjects, so that each one of you who attend these meetings will be able to get something of particular interest that you can carry back with you.

I do want to point out, however, if you will think back over your previous conventions and recall the various little details that you have taken home with you and put into practice, that the majority of those things have come by discussion, either with one person or with a group of persons. For that reason, I would like to urge you to discuss the papers here, so that we will get the most out of them.

For this morning's session, our Chairman will be Mr. Dan Boyd, Metallurgist of Northern Electric Company, Montreal, Canada.

Mr. Boyd. (Applause)

Chairman Boyd: Good morning, gentlemen. We have two very interesting papers to present to you this morning. I think Les has covered the details pretty thoroughly.

The first paper is "Spools for Shipping Magnet Wire," and will be given by Mr. Fred A. Rappalyea of the Hubbard Spool Company.

Mr. Fred Rappalyea. (Applause)

. . . Mr. Fred A. Rappalyea presented his prepared paper "Spools for Shipping Magnet Wire" . . . (Applause)

Chairman Boyd: Thank you, Mr. Rappalyea, for a very interesting paper.

I think you will all agree with me that this represents a new approach to the evaluation of the properties of magnet wire shipping spools, and I am sure we should have some interesting questions and some interesting discussion.

I will throw the meeting open now for questions and discussion.

There was one question that I would like to ask, myself. It sometimes has happened that enameled wire wound on shipping spools requires a low temperature bake, 300°F. usually, for the purpose of stress relieving and improving windability. How would your fiber glass plastic spool stand up for possibly two or three hours at this temperature?

Mr. Rappalyea: That is a good question, Dan. You say "300 degrees," above 300 degrees Fahrenheit. Will that be 300 plus or minus 10, or would it be 400? The reason I ask is because 300 happens to be the critical point of that fiber glass. At 300 degrees that is what we call the distortion resistance point. Beyond that, getting up to 350 degrees, your properties in your fiber glass spool will fall off just as will properties of metal at higher temperatures. That does not mean that it will cold flow, or hot flow, in this case or yield, but that means that it will have a greater tendency to distort under that load than it would at room temperature.

Now this is a relatively new field on these laminates, and we have been talking 400 degrees as the distortion point. If you were to go to 600 degrees you would burn out your resin and you would have nothing left but glass.

Does that answer your question, Dan?

Chairman Boyd: Yes, that answers the question, Fred. I think the job can be done under 400 degrees.

Mr. Rappalyea: I would say the thing to do on that is to try it, because we are all going along with this development, and the only answer we get is the answer from you people who use the spools.

Chairman Boyd: Is there somebody else who would like to say a word or ask a question here.

If not, we will go on to the next paper.

Thank you very much, Fred. (Applause)

"Magnet Wire Plant—Ft. Wayne Works—General Electric Co."

By F. A. Arnold

Our second paper this morning is entitled "New General Electric Company Copper Mill." This paper is to be given by **Mr. F. A. Arnold,** Metallurgist and Engineer of the Wire and Insulation Division of General Electric Company, Fort Wayne, Indiana.

Mr. Arnold. (Applause)

. . . Mr. F. A. Arnold presented his prepared paper, accompanied by slides, entitled "New General Electric Company Copper Mill" . . . (Applause)

Chairman Boyd: Thank you, Mr. Arnold, for a very well presented description of a well-laid-out plant.

Now I think there must be some questions and discussion following this paper, so the meeting is now open.

A Member: I am wondering if Mr. Arnold would care to amplify a little his mention way back in the trip, the receiving inspection on your rod? First of all, do you use a shaved rod? It looked awfully nice and shiny in the picture. You did mention your receiving inspection. What do you do to the rod when you take a look at it?

Mr. Arnold: I will be very glad to answer that as well as I can. Receiving inspection on copper rod is one of the things that has given us a great deal of concern. We have struggled for a long time to try to find something that might be indicative to the cleanliness and drawability of the wire, and I must admit we do not have anything.

We do primarily these things: We make tensile tests on each shipment. We also make a twist test, which we believe indicates somewhat the presence of seams and surface inclusions. We twist it up a certain number of times and examine it under a microscope. We do that on five samples, approximately, which we take from each shipment. If it is a carload shipment scattered at different points throughout the car, we make annealing tests on it. We actually take a section of rod and roll it out to a thickness which I don't recall now. We anneal it in a salt bath. We take hardness checks on it to see how well it anneals. I believe those things constitute primarily the receiving inspection, as such.

The thing we like to do is to take a few coils from each shipment and route them through a drawing machine, draw them down as quickly as possibe to a finish size and then establish the quality of the whole shipment on the basis of that. That is rather difficult to do, however. It hasn't worked out too well. I don't want to convey to you that that is our established practice. We have done it and we like to do it.

I might say one other thing. The rod we get comes largely from Indiana Rod and Wire Company, located right in Fort Wayne, the Phelps-Dodge Plant across town. We receive our copper now largely in truck shipments, right across town. We do our pickling ourselves. We do not scalp bar a rod. We have been receiving what we believe to be a very good grade of copper wire rods.

Does that answer your question?

A Member: Thank you very much.

A Member: One further question along that same line, you mentioned that the rods were not from scalp bar. Do you shave the rod?

Mr. Arnold: I believe I didn't mention that. We shave a part of our production. We don't shave it all. We shave for customers that ask for it, both within company and without. We have certain demands and certain requests within the company for which it is felt that shaved rod is desirable and for that part of our production we do shave. We do not shave it all.

We feel wire from shaved rods gives us, what you might call as far as we know, the acme of quality today.

A Member: One other point on that, do you feel that shaving a rod has a material effect on drawability to finer sizes?

Mr. Arnold: We do shave all the wire that goes into fine sizes. We shave that entirely. We feel we get less breaks when we do it, because a lot of these inclusions on the surface, by the time you get down to fine wire, become a major cost cross section of the wire. By shaving we get those off right at the start.

We are inclined to believe that shaving does not help die life particularly. I don't believe it lessens breaks in the major sizes, in the larger sizes of the wire. It may not give us any more. We don't benefit one way or the other in that respect from shaving.

Does that answer your question?

A Member: May I be a pest again? You mentioned that you disregarded, may I say "disregarded", using Brown and Sharp numbers. I am wondering if you do that in your drawing operations? On the machines, I believe you said, as I recall, you were going out at 008 and coming out at 1131 to a 16 inch die machine.

Mr. Arnold: We don't go into 008 on the A machines. On the A machines we go in, I believe we have two sizes, standard 002 and the other 032. Now when I said we disregard Brown and Sharp sizes, I did not mean to say that we abandon Brown and Sharp's sizes. We use the sizes, but don't speak of them in sizes, Numbers 24 on to 36. We express it in decimals. That is what I should have said, and if I conveyed the other impression, I am very, very sorry. I didn't mean to do that.

All of our wires, our dies, are made to A.W.G. sizes and if there is any confusion on that, I hope it is cleared up.

A Member: I noticed that you said that you only had three systems for your lubricant in your drawing department. Do you find any difficulty operating your A and B machines from this same lubricant?

Mr. Arnold: Emphatically yes. We feel that that may be one mistake we made. We end up with a compromise for those two ranges or sizes of machines, and I believe it would be helpful to us if we had a fourth system.

A Member: Did I understand you correctly that the rod was not made from scalp wire bars?

Mr. Arnold: Our wire is not made from scalp wire bars. That is right.

A Member: Thank you.

Chairman Boyd: I will ask a question of Mr. Arnold. Do you—maybe we could get some comments on this—do any process annealing in the wire drawing line before you reach your enameling department?

Mr. Arnold: We anneal only ahead of the A machines. That is we don't anneal ahead of any of the other machines, except the A drawing machines for fine wire.

Chairman Boyd: Does anybody have any comments on that angle?

A Member: I don't have any comments, except to say that we don't anneal at all.

Mr. Arnold: You don't anneal at all, not even ahead of the A machines?

A Member: I beg your pardon, we anneal after the drawing is all over, but we do no process annealing.

Chairman Boyd: I was referring to process annealing in the wire drawing.

A Member: No, we do none at all, and our largest fine wire runner is 0034. We do no annealing at all all the way down the line.

Mr. Arnold: We have done some manufacturing in that manner, but, as you know, Mr. Boyd, I was a little confused myself when you were there, whether we were or were not at the time. I further checked that, and we are. I meant to say, we are not running it on anneal.

Chairman Boyd: Do you find that it is actually beneficial in the A machines to do that process?

Mr. Arnold: Our wire drawing people do. I cannot say anything about that. I really don't know. I know we are doing it.

A Member: I just wanted to say the English firms drawing copper wire do hardly any annealing. I don't know one who does any annealing at all now from the rod right down to 001.

Mr. Arnold: That is very interesting, I am sure.

A Member: I might also make a remark about that. I think it is more beneficial to use hard wire clear through your operation. You carry over a certain percentage of soap or lubricant on your wires and you bring it to your next machine and, consequently, the wire on the first die is not nearly as grayed by using the hard wire.

Mr. Arnold: It appears we might do some further experimenting again and revert back to former practice. There seems to be a lot of evidence to substantiate that.

A Member: I might add on that, especially on drawing of bronze wire, we have found that annealing is very damaging to the first die, because apparently the grain size is larger and the material is much more abrasive, and some of that material we have annealed for special reasons, not to make the draw better, and the dies would wear out so quickly that we would hardly be able to draw a full coil of wire without changing dies.

A Member: When you do shave wire, your product, how do you expect to do any process inspection at that point?

Mr. Arnold: We inspect it, of course.

A Member: Do you mean the coil, after it is shaved?

Mr. Arnold: Oh, no, we do not inspect it, only the visible appearance that one gets after the test, casting his eye over the spool.

A Member: Do you do any twisting?

Mr. Arnold: Yes. Do you do any?

A Member: Yes, we do. We find very often the machine becomes out of alignment and you are shaving 99 per cent on one side of the wire, even though you have a chip. Sometimes you cannot see exactly how good a job you are doing at shaving. Frequently that chip breaking mark is covered over by a film of copper on the draw-down operation. Occasionally it is twisted and you can see your defect. I twist every sample of every large spool and we shave one sample of every spool.

Mr. Arnold: I think your practice is followed by other people.

A Member: I know other people who are doing that, yes.

A Member: I would like to ask two questions, one is, have you experienced any difficulties in the process annealing due to the appearance of unwanted ingredients in the atmosphere and what precautions have you found it necessary to take to prevent that?

The other question is, could you give me any information—or some more information as I have not read the paper in detail, and maybe it appears in the paper—as to what speeds you are drawing the various sizes? We have heard of phenominally high speeds being used in this country and I wondered what speeds you have chosen in this modern mill, as a result of previous experience in this country?

Mr. Arnold: To answer your first question, I don't know of any particular trouble we have had in that on our preanneals. Of course, if the converter unit gets out of adjustment, we do regularly take horosights on that. It is not the last word, but it gives us some indication. We do that regularly. If the thing does get out of adjustment, you immediately get a discoloration on the wire. You can see by just glancing across it. It is readily apparent. I know of no particular trouble. The greatest trouble we have and have had, I believe, is due to the wrong slope in our gas line, in some cases, from these batteries of converters to the machines, and we have water accumulations in

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FRIDAY, OCTOBER 21

Afternoon Session—2:00 P. M.

	Dr. Bruce W. Gonser Research Supervisor, Non-Ferrous Metallurgy Chairman of Meeting	Battelle Memorial Institute Columbus, Ohio
PAPER: "Protective Atmospheres for Annealing Non-Ferrous Wires"	E. G. deCoriolis, Dir. of Research and Orville E. Cullen, Chf. Metallurgist	Surface Combustion Corporation Toledo, O.
PAPER: "New Development in the Tinning of Wire"	Herbert Hirschland Research Department	Metal & Thermit Corp. New York, N. Y.
PAPER: "The Nylon Coating of Wire"	C. A. Litzler Chief Engineer	Industrial Ovens, Inc. Cleveland, O.

"Protective Atmospheres for Annealing Non-Ferrous Wires"

By deCoriolis and Cullen

The Technical Meeting of The Wire Association reconvened at two o'clock, Dr. Bruce W. Gonser, Chairman, presiding.

Mr. L. A. Whitney: You will find that we have three papers on this session, and I am sure they will all be very interesting.

I would like to turn the meeting over to Dr. Bruce Gonser, Research Supervisor, Non-Ferrous Metallurgy, Battelle Memorial Institute, of Columbus, Ohio.

Chairman Gonser: We will start with the first paper immediately, as I know there are many of you who want to get away this afternoon without too much delay.

Our first paper is "Protective Atmospheres for Annealing Non-Ferrous Wires," by Mr. E. G. deCoriolis who is Director of Research for Surface Combustion Corporation, Toledo, Ohio and Mr. Orville E. Cullen, Chief Metallurgist of that Company. Mr. Cullen will present this paper.

. . . Mr. Orville E. Cullen presented the prepared paper on "Protective Atmospheres for Annealing Non-Ferrous Wires" . . . (Applause)

Chairman Gonser: The paper is open for discussion. Mr. Cullen is here conveniently and will answer anything in regard to this subject of controlling atmospheres or anything remotely connected with it. (Pause)

I notice and certainly agree with you that sulphur is one of the bad contaminents. We used to think that the only way to handle sulphur was to take it out by scrubbing, but I am glad to see that by using a lean atmosphere it can be burned out rather well, and SO_2 is not particularly bad.

Would you like to make any further comment on that? For instance, you mentioned that if necessary, or if desired, one can put in a scrubber. When is that necessary?

Mr. Cullen: That is essentially correct, Doctor. There are instances where in the use of manufactured gas, particularly the sulphur, even in a lean atmosphere it may pass through, leaving a certain amount of hydrogen sulphide. Usually that amount is extremely small, however. Possibly the most important thing is a scrubber to remove the SO_2 in these so-called rich protective atmospheres.

Here, perhaps, we have 10 per cent to 19 per cent hydrogen and it is absolutely necessary to remove the SO_2 because, once that enters the furnace, the hydrogens will again tend to form hydrogen sulphide for the SO_2. Therefore, a water scrub tower is inserted after the tests have gone through the generator.

There is a distinct reason for doing it afterward, after taking the SO_2 out, before going to the generator. If sulphur is present in any form, except H_2, it will have burned in the combustion chamber. It forms either F_2S or SO_2 again. Therefore, for work involving these non-ferrous alloids and, particularly silver or semi-precious metals, the usual combination is a spray tower and the oxide tower after the gas has been produced.

Chairman Gonser: Are there any questions from the floor?

A Member: I would like to ask what sort of atmosphere you recommend for a 5 per cent or an 8 per cent bar? Do you have any experience with that?

Mr. Cullen: I will be frank with you. I have had very little, and I wouldn't want to answer that without a little investigation. Perhaps Mr. deCoriolis or Mr. Owen may have had some experience with aluminum bronze, but I have not.

Mr. deCoriolis: We have no protective atmospheres for aluminum, since any oxygen present in the atmosphere at any time will oxidize an aluminum, and you cannot reduce it. If you can start with something slightly pure and have no air of any kind, it will oxidize and you can use any hydrogen bearing atmosphere to prevent the oxidation, but there is no chance of deoxidizing it.

We had this little discussion right before this meeting on the question of hot-dipping steel in aluminum for the prevention of oxidation, and that is just as important to prevent the oxidation as to deoxidize, as Mr. Cullen has brought out; and, therefore, you must first start out with a product which is, first of all, clean. Too frequently we get into this problem of how to bright anneal. Well, we have our drawing compound on this thing.

Quite recently, we had an experience, which didn't happen to be in wire, but it was in copper, which is most successfully annealed in the bell-type of furnace, where, first of all, the atmosphere there was steam. Steam for copper works perfectly well. In the process of heating the metal up to temperature, steam entered the bell in which the metal was contained and there proceeded to go to work and sweat out the lubricants, as they say.

When the lubricant was all through and you had no difficulty subsequently, we cooled the metal down in a dry combustible type of furnace. The product came out and everything was bright. Then it was switched from a batch-type of furnace to a bell type to a continuous furnace. What happened in the continuous furnace, as in the first part of the furnace, where it was coming out, you were sweating out the lubricant, and over here you were keeping up the temperature and bright annealing it. This oil coming off was simply mixing over there. For the first time these people realized they had sulphur in the lubricant and the sulphur went to work and mixed over there and when it came out it was discolored with sulphur.

You say "bright annealing," and we say "yes," but your metal must be free and clean from any foreign matter, and I cannot emphasize that too much in this whole business. After all, a protective atmosphere is not a cleanser. It cannot clean the metal for you.

If the lubricant will vaporize most readily and it is a type of pure hydrocarbon which vaporizes readily and you can get a sufficient sweep of atmosphere, you get rid of it as it comes into the charge in the furnace and you have a good chance of keeping the metal clean. But if there is any sulphur on this, you are out of luck because there is nothing you can do, unless you work with a terrific flood of gases through there, and that is not sound economically.

The same thing applies to wire, in the case where some very heavy drawing compounds have been used and left on the wire and then the wire is introduced into the furnace. You can vaporize in all the petroleum compounds, but anything having to do with fatty matter and soap will simply bake out and there is nothing you can do about it.

Chairman Gonser: That is a very good point. You can have a clean atmosphere, but you cannot keep it that way if the work comes in with a lot of oil and junk on it.

A Member: My question was on aluminum bronze. Does that apply also to aluminum bronze?

Mr. deCoriolis: There is no use. Aluminum oxidizes if you look at it. You never see a piece of aluminum that is bright. There is always a dull color to it. You have aluminum zinc and copper and that aluminum is going to oxidize. You can do a fair job of cleaning and then you will get atmospheres, but absolutely the only way to get bright an-

nealing is to simply clean your surface. Apart from that, I don't know what language to express it in. You might say it is reasonably bright, but it is a question of how much is too much.

Chemically clean your surface. When we talk about clean annealing, it is anything you might be satisfied with, or which is commercially satisfactory. In drawing a fine bead on there, it must be pure and absolutely clean. There are a lot of things that are perfectly passable in commerce and don't have to answer to a certain performance.

Chairman Gonser: In aluminum bronze, of course, you would get a film of aluminum oxide. You do with any aluminum containing alloy. It, alone, is a clear film and should not bother you. What you meant was a copper discoloration?

A Member: Yes, and it is very difficult to remove.

Chairman Gonser: It is prevented by keeping the copper from forming an oxide or sulphide. Not knowing all the factors in your problem, I would say any of these good atmospheres would prevent copper from becoming discolored.

A Member: The problem I was thinking about was a small experiment in which we annealed this aluminum bronze in the same atmosphere we used for copper, 10 or 11 per cent CO, and the resulting material was somewhat discolored and very difficult to clean up afterwards.

Mr. Cullen: There was one thing in that connection we might mention that isn't true particularly with aluminum bronze, but we do know silicon bronze has been handled quite successfully with this atmosphere I described, where all the SO_2 was removed, scrubbed out, and all the sulphur, of course, and where we had nothing really left except a trace of SO_2 and a trace of hydrogen to prevent free oxygen, and the balance was nitrogen.

That atmosphere on silicon bronze has done what is considered to be acceptable or more than acceptable work, and it might be that it would be along that same line, because silicon is just about as difficult and more so than aluminum.

A Member: Thank you.

A Member: Would you say that it was possible to bright anneal brass in a batch-type furnace, where the time necessary will cause gray discoloration on brass?

Chairman Gonser: Did everybody hear the question? Will you state it again, please?

A Member: Is it possible to bright anneal brass in a batch-type furnace, where the time and temperature necessary would cause gray discoloration?

Mr. deCoriolis: Brass is one of the most difficult metals to bright anneal, and I have bright annealed brass and under the conditions that the rate of annealing is so rapid that the time for what is called "zinc blue" is reduced to a minimum, so that the surface appearance looks white.

All the same, it isn't very difficult to go to work and anneal in an atmosphere that reduces copper very readily. You can reduce the gases and there is an atmosphere that is not only protective but also reducing and will bring this oxide back to a metallic form. There is nothing that is going to prevent the zinc from vaporizing at the surface, except for one thing: You can go to work and in the atmosphere itself you can saturate the zinc to at the dew point, and first of all I heated the particular atmosphere, or heated the brass at the same protective atmospheres and at the temperature and the atmosphere you pick up and conveyed that zinc as a vapor, the same as water vapor is carried in a cloud, and, therefore, no more zinc would boil off or effervesce. That is not so particularly with brass, and the answer has been, generally speaking, one of the best treatments for brass.

You let it oxidize and pickle it off because zinc oxide can be pickled so readily. Of course, first of all, you put an atmosphere in there which was going to protect the brass. Actually what is taking place is you allow some air to get into that place which will do two functions: It burns up the lubricant that is there and gets rid of it and there is a slight zinc blue, and you come down to a quick cooling zone and into a pickling tank and you come out with that brass as bright as any. There is no more labor to it.

The cost of pickling is reduced down to a minimum, and, therefore, you get your product. So I say, theoretically, we can bright anneal brass, and in most cases it is far simpler to go to work and let the brass slight oxidize because, don't forget, it is one of the simplest ways of getting rid of the lubricant. Otherwise, what you would have to do is go to work and pass it through a cleaning bath first of all to remove all that lubricant, and if you had a lubricant that wasn't soluble in water, you would have to go to work and use a material that would dissolve the hydrocarbon and that is extremely complicated, and because it would require so many applications we wouldn't recommend it.

Chairman Gonser: Some of the metals being handled now are so active that one must use nitrogen, helium, argon or an inert atmosphere so there is no reaction whatever.

Since our time is pretty well taken on this, we will let you go, Mr. Cullen, and thank you and also thank you, Mr. deCoriolis. (Applause)

"New Development in the Tinning of Wire"

By H. Hirschland

The next paper is on the timely subject of "New Development in the Tinning of Wire." I say it is "timely" because now tin is available for anyone without any restrictions on its use. In the past one didn't need to worry about papers on the subject, because you couldn't get tin anyway, even if wanted for a new or improved application. Fortunately that is not true now. This paper is by Herbert Hirschland and Frederick Lowenheim of the Research Department of Metal and Thermit Corporation. This paper will be presented by Dr. Frederick Lowenheim. (Applause)

. . . The paper on "New Development in the Tinning of Wire" by Herbert Hirschland and Frederick Lowenheim was presented by Dr. Frederick Lowenheim . . . (Applause)

Chairman Gonser: The paper is now open for discussion.

A Member: Do you ever tin stainless steel? We have calls for hard drawn stainless steel for armature banding, where they require tin coating.

Mr. Lowenheim: We tried that with the fused salt method and it is not at all successful so far. As far as electroplating on stainless steel is concerned, I would guess, without knowing, that the problem is in the pretreatment of the stainless. You can electroplate other things on stainless, so there is no reason why you shouldn't be able to electroplate tin. I don't happen to know, off hand, the treatment that would be necessary. It can be done.

A Member: For tin, on the basis of standard running conditions, what is the comparative cost between the hot-dipping of copper and the electroplating process.

Mr. Lowenheim: That is the $64.00 question. Of course, I am not prepared to answer that off hand. I would like to be able to think about that. We believe in the overall, it is cheaper, otherwise we wouldn't be advocating it, and, certainly, a number of people agree with us on that; but a detailed economic study would have to be made in each individual case.

A Member: You have never made a comparison?

Mr. Lowenheim: We have made a comparison for specific customers at their own individual requirements. We never have made any comparisons that we believe would be generally applicable to the whole industry. So many things depend on the individual company's capital setup. Your capital cost for electroplating is a good deal higher. Once that equipment is in, the running cost and the material cost is probably lower, and it depends on how much you are willing to spend in capital to save in operating costs.

A Member: We have never used the hot dip method, but in our case we have per season users who wish to have electroplated tin copper wire, but the users are very critical.

Mr. Lowenheim: Do you mean the quality?

A Member: Yes.

Mr. Lowenheim: I have no hesitation, as far as quality is concerned, that electroplating can do as good or a much better job than hot dipping.

Chairman Gonser: There is a chance to do a much better job, because there is no chance of flux adherence, for one thing.

Mr. Lowenheim: Flux adherence, specks and draw dirt from the hot tin pit and you have much more control of what you are doing.

A Member: What has the experience been with coating of aluminum wire?

Mr. Lowenheim: It is an interesting question. I can give a very quick answer on that and say we have had very little experience, of course, but it is something we have given a lot of thought to. We can coat aluminum not by electroplating, but simply by emerging in standing solution. All automotive pistons are done that way. They are aluminum alloys. Aluminum alloys are easier to handle than pure aluminum. I have no doubt but what the problem could be worked out in pure aluminum, but as far as the coating of pistons is concerned, that is carried on on a very, very large scale by the automobile industry, and it is quite a well standardized procedure. Does that answer your question?

A Member: Yes, thank you.

A Member: When you mentioned quality, comparative quality, between hot-dipping and electrotinting, how would you compare that—you mentioned, of course, the quality regarding the protective coating—or how would you regard that quality compared with respect to solderability?

Mr. Lowenheim: There has been a good deal of argument about the solderability of electroplated tin, but most of that has been on the unreflowed tin. After the tin is reflowed, I seriously don't believe there should be any difficulty with soldering, and if there is, it is capable of being done by one of several methods. After reflowing, instead of quenching in water, you quench in a chromate solution, which is the method the steel industry has adopted. The solderability problem for electro tin plating has been solved that way and I see no reason why it shouldn't be solved in a similar way with wire.

Chairman Gonser: Quite often in electroplating one finds that the thinner the tin, the more difficult it is to solder the tinplate.

Mr. Lowenheim: That is true, but even in the case of water on tin plating, which has one-sixth as much tin on it as standard tin plate, the soldering has been solved by the can industry and the steel industry, although it was a problem at first in the early days of electro tin plating.

Chairman Gonser: This solderability problem in the case of electro tin plate was made worse by the necessity of making cans for very rapid soldering operations. The solder had to flow in the seam at a very fast rate, and the same condition might not hold for, say, copper wire connections and so forth. A very, very thin tin coating might be ample for many applications. We find, of course, that it is necessary to flow the tin coating to get the best results. You can buff tin electrocoatings very easily, and I am wondering if on wire, which is more easily handled, one might not get by with pulling it through some light wiping or mechanical rubbing mechanism.

Mr. Lowenheim: I did suggest, of course an additional one draw after plating, even a very slight reduction would do it, and that is somewhat similar to what you are proposing. I am sticking to reflowing, however, because that has been found, at least in the case of electrolytic tin plate, to not only improve the finished appearance but it closes the pores. You have pores and we are dealing with extremely thin materials, and such materials are porous, and anything to reduce the porosity would be very well worth doing.

Chairman Gonser: Do you find that flowing reduces the porosity?

Mr. Lowenheim: The can companies seem to think it does.

A Member: When we speak of coating thicknesses, maybe we can get together. What do you fellows consider tin coating? We just talk about wire in milligrams per square inch.

Mr. Lowenheim: I am sorry, I can't answer that off hand. I am used to talking in terms of thicknesses, in terms of thousands of an inch or millionths of an inch or something like that, I can't transfer that to milligrams per square inch up here on the platform at this moment. I will be glad to answer that in writing for you.

Chairman Gonser: I think we have been considering a thin coating on tin plate as something on the order of two or three hundred thousandths of an inch thick.

Mr. Lowenheim: I can mention that as far as a half pound of electrolytic tin plating is concerned, it is a coating of 30 millionths of an inch and 15 millionths.

Chairman Gonser: Are there any other questions?

Dr. Lowenheim, I think it has been quite important for you to mention this new development of using a one per cent aluminum-tin anode, because that certainly does simplify problems in the electrolysis of tin. It is an important thing and I wish to emphasize it.

Mr. Lowenheim: I might point out, in applications where this wouldn't be true so much of electro-tinning wire itself, but in applications like tinning of cloth and braided wire, where possibly the cost of the tin is not such a large factor, it is quite satisfactory to use steel alloys and forget about it. It is expensive to get your tin from chemicals, but where the amount of tin falls in that rate, it does do away with about 50 per cent of your control.

Chairman Gonser: Are there any other comments?

It is nice to have some men here who know electrotinning and other methods of tinning. I would like for you to take full advantage of this opportunity if you have questions in this line.

If there are no further questions, we will go immediately to the third and last paper of the session. (Applause)

"The Nylon Coating of Wire"

By C. A. Litzler

The name of this paper is "Nylon Insulation," and it will be given by Chief Engineer C. A. Litzler, of Industrial Ovens, Inc., of Cleveland, Ohio.

Mr. Litzler. (Applause)

. . . Mr. C. A. Litzler presented his prepared paper on "Nylon Insulation" . . . (Applause)

Chairman Gonser: The paper is open for discussion. (Pause)

I noticed early in your talk, you mentioned as one of the advantages, that nylon was very easy to dissolve, by merely heating it to make it drop off. Does it have any fluxing properties whatever?

Mr. Litzler: Yes, it does, and those properties, I believe, are much more apparent again in the direction of its maximum length or extruded length than cross dimension. Now this soldering is especially important to a radio manufacturer, or to anyone interested in assembly of small parts, where there are a lot of soldered connections. In that case, we do not have to mechanically strip the wire, and it would be advantageous. We have seen installations where the mechanic simply touches the wire and the nylon seems to vaporize and I think that has some important commercial aspects.

Chairman Gonser: It certainly would have.

A Member: In bending you seem to give your cable or strand in nylon, do you have any bad effect on that afterward; I mean, in sets of any kind?

Mr. Litzler: The fact that it is nylon, I don't think would make any difference, but do you mean from a cold working point of view?

A Member: We are extruding nylon onto strand and steel wire, high carbon mostly, and we have found that after we run this covered strand on to a take-up reel and we let it stand there, it takes a certain set. In other words, like a ring, which we don't like. We like to have our rope in a dead form; in other words, straight, without any deviation from a straight line, and I was wondering whether your reverse bends will take care of that, or the extra drive when you have it covered, when the nylon covered strand comes out of your cooling trough and then goes up and then back, I understand? Does that take care of it?

Mr. Litzler: I didn't mean in any of these slides to say "This it it." They were all typical. I think the problem is more one of large diameter shives and more accurate control of wire tensions. Quite a bit of difficulty is encountered in using small diameter capsules or small wire guide shives, where wire is actually cold worked and stressed because at times its tensions might be high, and I don't think it would assume that shape if it weren't for the fact that the material was stressed maybe too much.

A Member: I appreciated particularly your remarks about the pulsation you get from the let-off reel. We have experienced considerable trouble at that point, because any slight pulsation

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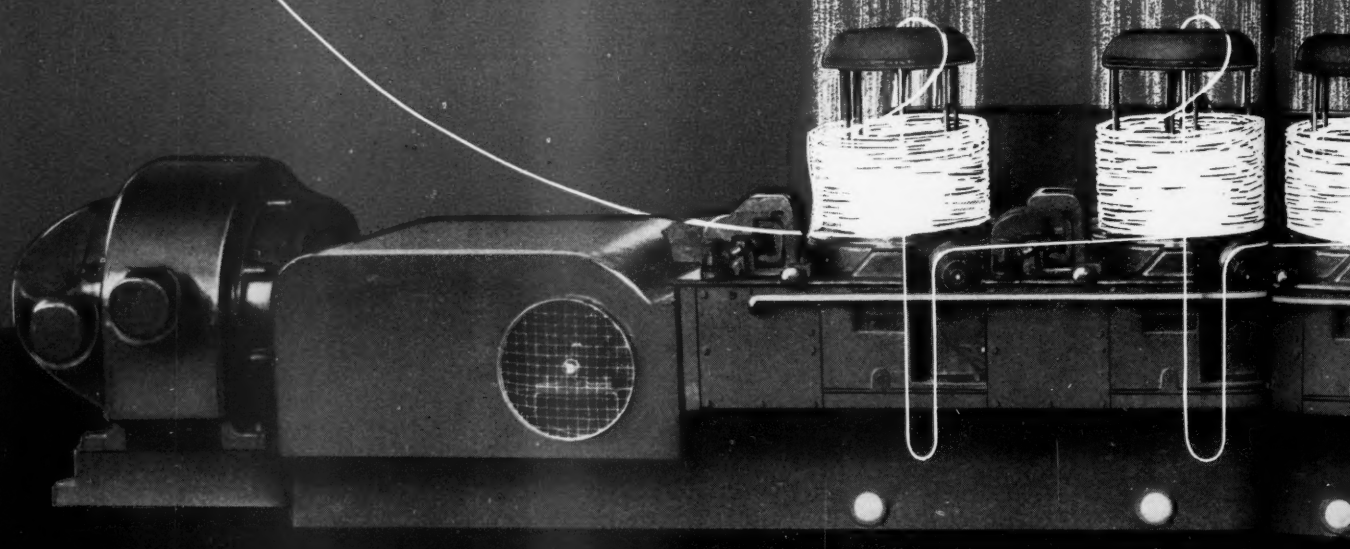

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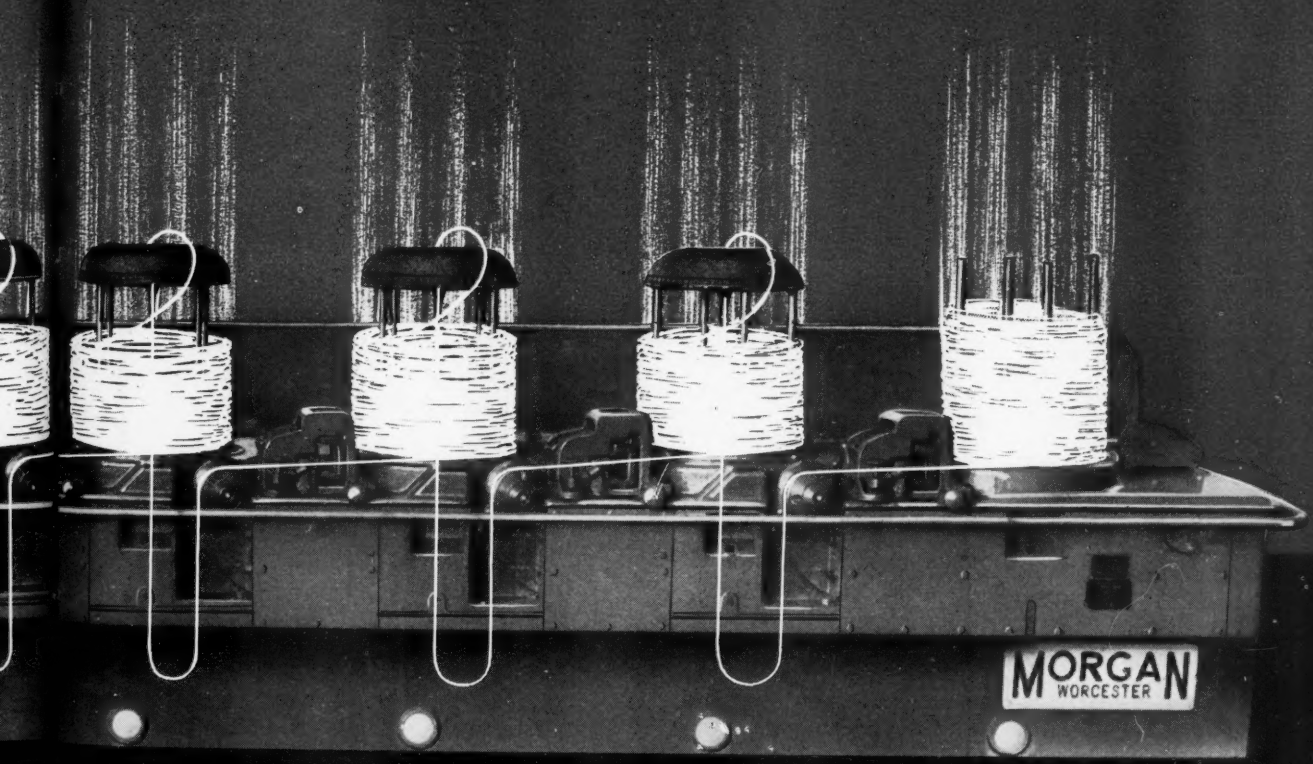

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there, of course, gives you a heavier or thinner coating, which is not very desirable, and I should like if you could explain that just a little bit more to me; how you overcome that pulsation?

Mr. Litzler: Well, I think it is more an academic question as to what is tension and what is a constant tension. The problem itself is one in which you set up a known and given stress in the strand. That stress can parallel, obviously, to the length of the strand. Now if the wire itself is only contacted with shives that will measure the difference in speed synchronization, which is differences in tension again, you take the load of doing the work off of the wire, and that is the principal reason for driving on nylon strands, regardless of what the operation may be, because then the wire is not used to apply the force to the reel of turn. You can readily see that your square, 36 inch, 500 pound reel, is way up in pounds per square feet, and way up above the breaking point of the wire and obviously you cannot run any wire on any type of process in anywhere near those tensions.

A Member: May I relate how we have been doing it, which I think is a little crude, but nevertheless has been tried, and while we have been somewhat successful, I think it still could be improved upon. We just have a simple let-off stand with the reel mounted on a shaft, of course, and then we apply a rope tension. We, of course, had to go to sometimes as much as using a half ton chain fall in order to regulate it more correctly, and to eliminate any of that jerking you would get from pulling it off under its own force. In other words, the haul off would do the pulling. We did not have a driven let-off as you have shown us here, and that probably is, therefore, not quite as well done, or as correct in its application there, but we have been managing to get a somewhat smooth operation. As you come to your corners, however, in your overlapping at times you get a pulsation.

Have you overcome that completely, even though you have a driven let-off?

Mr. Litzler: There are hundreds of extrusion installations that have no constant tension devices, as such. We are also not naive enough to believe constant tension is needed all over, at the corners of a reel, and it is too difficult, I mean, regardless of the equipment point of view. It is an overall academic problem of guiding the wire or providing for the reels to wind in such a way that they will wind properly. Do I make myself clear?

A Member: Yes, thank you.

What is your recommended cooling temperature?

Mr. Litzler: It depends, because it varies with the nylon. It is usually 60 or 70 degrees. Again, that is a relative problem, relative to the extent that if you have a thousand feet, it would be ridiculous to cool—you could cool with ten feet of water, and if you have ten feet of wire, you have to use refrigerated water. Nylon doesn't seem to be susceptible to cold. You can hit it with cold water, whereas materials like polythetlin, you have to go through zone cooling, because it will thermoschock out. Does that answer that?

Chairman Gonser: You mentioned, in discussing the solution method, of putting on half a mill coating at a time, and that to get on several mills thickness, it would take a number of passes through. Can you control the viscosity of the solution and die aperature so that you would get on more than half a mill coating? What kind of problems do you run into there?

Mr. Litzler: You could do that, but you would get into the problem of having too thick a mass to drive the solvent from, and that can be answered by increasing the time and higher furnaces, and that becomes economic.

Chairman Gonser: How about using infrared heating for drying if it becomes thicker?

Mr. Litzler: If you could obtain high temperatures, it would be impractical, but infrared is a radiant type of energy and you also have the problem of patterns, due to circular cross sections of the wire, and other than that the transmission of energy. You take in these electroheated furnaces and in gas too, you deal with transmitted infrared energy, but nobody sets out to transmit to the material by infrared or by convection. The problem is principally to get the heat in the wire in the shortest space as possible and in general operations you don't blister the surface.

Chairman Gonser: Have you ever heard of anyone trying to use electrophoretic means of putting on the coating?

Mr. Litzler: No, that is one we never heard of.

Chairman Gonser: It has been used, or at least suggested, for silicones and polyvinyl type resins, but undoubtedly the method you are using is the most practical.

Mr. Litzler: Actually if you consider some of these problems from a laboratory point of view, there is a lot that could be done on the development of different heat transforming methods, but actually in the production world they are more or less concerned with getting something that will do the job with the minimum amount of research, but I do think it is a field where some research and laboratory work should be done.

Chairman Gonser: Are there any more questions?

If not, we will thank you for your patience in waiting. You stayed to the very end of our meeting.

The meeting is adjourned.

. . . The meeting was adjourned at five thirty o'clock . . .

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LeRoy D. Seymour Resigns as President of the Wire Association To Assume New Responsibilities

IT is with a very sincere regret that the resignation of **LeRoy D. Seymour** as President of the Wire Association, effective as of January 1, 1950, is announced.

★ ★ ★

L. D. Seymour, Secy-Treas. & Gen. Mgr., Marsgall-Richards Machine Co., Ltd., Trenton, N. J.

MR. Seymour, or Jack, as he is popularly known to most of the members, was up to the end of the year, serving as Manufacturing Manager of the Wire Division of **John A. Roebling's Sons Company** of Trenton, N. J. Always an enthusiastically active member, and for the past two years, President of the Wire Association, his interest in the affairs of and his leadership as President, have contributed materially to the development and success of the Association.

★ ★ ☆

PRIOR to his becoming a member of the operating staff of Roebling's, Mr. Seymour served as assistant Works Manager of the Steel Company of Canada, Ltd., Canada Works at Hamilton, Ontario. He worked there under John C. Callaghan, who until his resignation three years ago had been a member of the Association for many years.

★ ★ ★

MR. Seymour will be succeeded as head of the Association by **Fred Crapo,** President of the **Indiana Steel and Wire Company** of Muncie, Indiana. Mr. Crapo has been senior vice president of the Association and now will serve as acting president until the election of officers in April, 1950.

★ ★ ★

MR. Seymour's resignation as President is the result of his changing his Wire Association membership status from an "active" to an "associate" by reason of his entering a new occupational enterprise,—the wire machinery business—and ceasing thereby to be a wire mill operating man. The Association's By-Laws provide that only "active" members are eligible to hold office in it.

★ ★ ★

AS of January 1st, Mr. Seymour became the Secretary-Treasurer and General Manager of a newly-organized corporation in this country formed by the **Marshall-Richards Machine Company, Ltd.,**

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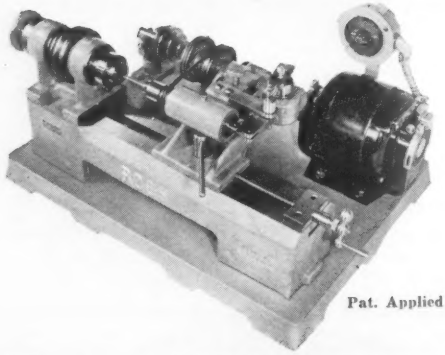

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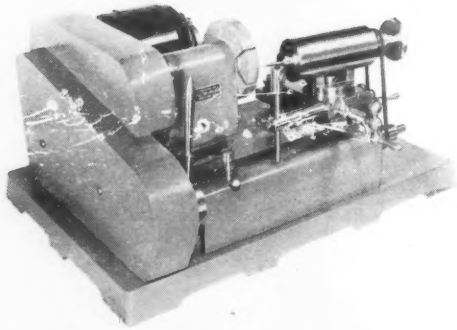

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of Crooks County, Durham, England, manufacturers of wire, tube-drawing and other equipment. The new concern has been incorporated in the State of New Jersey as the Marshall-Richards Machine Company, Inc. Its principal office is located at 1100 South Broad Street, Trenton, N. J., from which point the concern will devote its efforts to the sale of Marshall-Richards wire mill equipment in America.

★ ★ ★

MESSRS. **GEORGE BRYDEN, S. H. Richards** and **T. B. Somerville,** together with **L. D. Seymour,** have been elected directors in the new company.

★ ★ ★

THE parent company has long been known in Europe for its pioneering and leadership in the design and manufacture of wire drawing equipment. The wide and increasing interest shown by American wire men in this machinery has necessitated a closer contact with them that is possible only through the establishment of an American representative.

★ ★ ★

ONE of the recent outstanding developments of the Marshall-Richards Machine Company, Ltd., is the cold-cathode, grid controlled mercury-arc rectifier which produces, with direct-current motors, a minimum speed for threading up and a complete range of needed variable speeds for drawing quality into the wire.

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ANOTHER development is their permanent-magnet spool drive, through which amazingly simple torque-transmitting spooler, is provided a constant spooling tension that can be adjusted from zero upwards, a factor that is of great importance in fine-wire drawing.

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MR. Seymour will be able to offer the American wire industry a complete line of equipment for drawing wire from as heavy as one inch in diameter down to as fine as .0004" diameter, togeth-

er with accessary equipment of advanced design.

★ ★ ★

MR. Seymour will carry with him in this undertaking the hearty good wishes of his wide circle of friends throughout the wire industry for a full measure of success.

★ ★ ★

Dept. of Commerce Announces the Development of a Superior Alloy

FURTHER promising developments in "nodulizing" cast iron to improve its strength and ductility are reported in a brief review released recently by the **Office of Technical Services of the U. S. Department of Commerce.**

★ ★ ★

THE review describes work by the Naval Research Laboratory in the development of a superior alloy for this purpose, consisting of 8% magnesium in a ferro-silicon carrier.

★ ★ ★

THE information on nodular cast iron, along with details on various other developments arising out of federal research, appears in the current issue of the "Technical Reports Newsletter" issued monthly by OTS.

★ ★ ★

OTHER subjects include: food dehydration; prevention of corrosion in shop practice; fungicide paint additives; shock mounts; photoprinting on cloth and wood; acetylene chemistry; and high-strength high-conductivity alloys. Reports on German progress in electric power engineering and wood products are also listed.

★ ★ ★

COPIES of the November issue of the "Technical Reports Newsletter" are available on request from the office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. or from U. S. Department of Commerce field offices.

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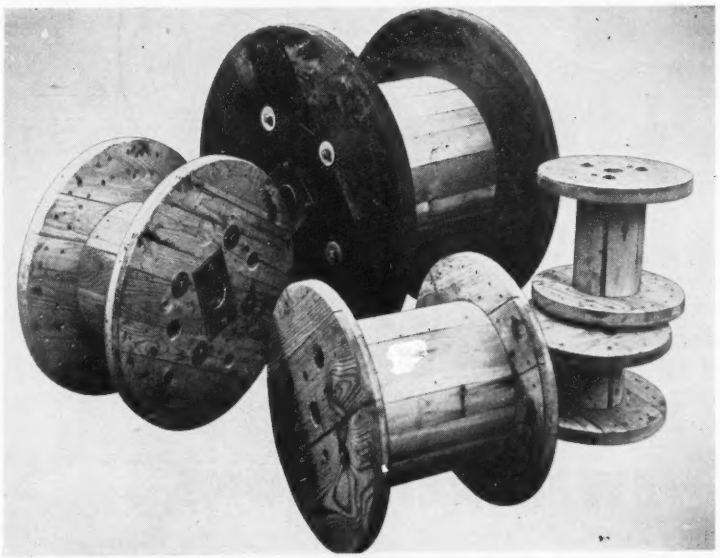

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Elmer A. Terwell Appointed By Rolock Inc.

ROLOCK INC., Fairfield, Conn., fabricators of heat and corrosion alloys, announces the appointment of **Elmer A. Terwell** as their Sales Engineer in the Chicago territory.

★ ★ ★

MR. TERWELL has had wide experience in the high alloy field with the Driver-Harris Company, The Salkover Metal Processing Company (of Illinois), and he has served as Secretary-Treasurer of the Chicago Chapter of American Society for Metals. His headquarters will be at 3382 Avondale Ave., Chicago 18, Illinois.

★ ★ ★

Youngstown Sheet and Tube Advances McConnell

JAMES McCONNELL of St. John, Ind., has been appointed superintendent of merchant mills at **The Youngstown Sheet and Tube Company's** Indiana Harbor Works. He succeeds **Fred A. Schuessler** who died last summer.

★ ★ ★

HIS first part-time job in industry was kick-off operator in the 12-inch mill of Forge Steel Wheel Company in Butler at the age of 16. This was followed by line jobs of billet yard stocker, open hearth clerk, stock boss at the Bessemer and open hearth and third helper in an open hearth department. He also served as a merchant mill foreman with Republic Steel Corporation in Chicago.

★ ★ ★

McCONNELL joined The Youngstown Sheet and Tube Company as finishing end foreman in the Harbor Works merchant mill in May, 1931. He was promoted to general mill foreman in 1936 and in February, 1938, was made assistant superintendent of the merchant mills.

★ ★ ★

Outstanding Personalities of the Wire Industry

Industrial Wire Products Corporation to Represent Roebling in Southwest

INDUSTRIAL WIRE PRODUCTS CORPORATION of Los Angeles and San Francisco is fast becoming one of the major jobbing units in the Wire and Wire Cloth industry on the Pacific Coast.

★ ★ ★

UNDER the management of its Vice-President, **Earl R. Potter** the annual sales volume is well past the quarter million mark.

★ ★ ★

MR. Potter has just announced that his organization has been appointed exclusive representative for **John A. Roebling's Sons Company** for all of Southern California, Arizona and New Mexico.

★ ★ ★

JOHN A. Roebling's Sons Company are manufacturers of all types of wire cloth and wire screening, and specialize in Industrial requirements, such as Chemical, Cement, Sand Gravel, Crushed Stone, Coke, Spark Arrestors, etc., and many special requirements that may be made to order.

E. R. Potter, Vice-Pres., Industrial Wire Products Corp., Los Angeles, San Francisco, Calif.

★ ★ ★

IT is with pleasure that Mr. Potter announces this new affiliation.

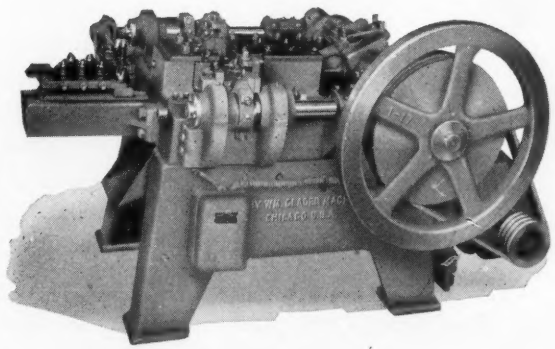
★ ★ ★

MR. Potter was for some 20 years Superintendent of the Wire Mill for California Wire Cloth Corporation in South San Francisco, having complete charge of all operations, which included the lay-out of their new $750,000 Wire Mill. Prior to that Mr. Potter was connected with the E. H. Edwards Wire Rope Company.

★ ★ ★

WITH his knowledge of the manufacture of all types of wire, Mr. Potter's expansion into the "Wire Products" field was in-

GLADER HIGH SPEED WIRE NAIL MACHINE



MACHINE ARRANGED FOR INDIVIDUAL MOTOR DRIVE

High tonnage output, and low maintenance costs, have resulted in Glader Machines being accepted as standard equipment in every large nail mill built in the United States in the past twenty years.

Glader Machines are operating in most of the wire producing mills throughout the world.

These machines are made in eleven different types and sizes. This enables us to cover the range of sizes of nails produced with the greatest efficiency.

For further information please address,

WM. GLADER MACHINE WORKS
210 No. Racine Ave.
Chicago 7, Illinois

Export Dept.: 122 E. 42nd Street, New York 17, N. Y.

evitable. In addition to handling all types of wire, wire cloth, netting, bale ties, welded fabric, etc., Industrial Wire Products Corporation specializes in straightening and cutting wire of all grades and types, and in addition offers its services in connection with the fabrication of complete metal and plastic units containing wire cloth for any special application.

★ ★ ★

G. E. Appointments

GENERAL ELECTRIC CO., apparatus department, Schenectady, N. Y., has promoted **Neil Currie, Jr.** from manager of manufacturing to administrative assistant to the general manager; **Ernest E. Johnson**, from manager of engineering to manager of engineering, large apparatus divisions; **Byron A. Case**, from assistant to manager of engineering, to manager of engineering, small apparatus divisions; and **Clarence H. Linder**, from assistant manager of manufacturing to assistant to the general manager.

★ ★ ★

Gross Heads New Laboratory for Tungsten Alloy

HARRY C. GROSS has been appointed Chief Chemist and Metallurgist by **Tungsten Alloy Manufacturing Company, Inc.**, 65 Colden Street, Newark, N. J., it was announced by Clermont Cartwright, President.

★ ★ ★

UNDER the new arrangement, the company has acquired G. & O. Laboratories which specializes in metallurgical analysis of powdered metals, formerly owned and operated by Gross.

★ ★ ★

PRIOR to setting up his own laboratories, Gross was with Westinghouse Lamp Company, Callite Tungsten Corporation and Sirian Wire and Contact Company, with which organizations, he had broad experience with tungsten and related metals, and tungsten carbide.

★ ★ ★

STUART TARKAN will assist Gross in the expanded company operations designed to accommodate industry on carbide problems.

★ ★ ★

American Smelting & Refining Company Appointments

FEDERATED Metals Division, **American Smelting & Refining Co.**, has expanded its business in electroplater's anodes through acquisition of production facilities of Metallurgical Products Co., Philadelphia. Production will be concentrated at the division's Perth Amboy, N. J., plant under the management of **R. D. Taylor.** The technical staff of Federated will be assisted by **I. W. Wilenchik** of Metallurgical Products Co., and the alloy and specialty products business of Metallurgical Products Co. will be conducted by **Mr. Wilenchik** from his company's Philadelphia plant, as in the past.

★ ★ ★

(ILLUSTRATED)
42" x 20" x 21"—(4000# cap.)

HEAVY DUTY

BREAK-DOWN REELS

1000#
2000#
4000#
} capacities

Rugged Design including patented DURA-CURL rim, and many other features necessary to provide the *Strength* and *Durability* needed for continued successful performance.

• • •

Also complete line of sizes of Modern High Speed Wire Drawing NO-CREV Spools and Reels for both fine and intermediate size wire.

MOSSBERG PRESSED STEEL CORP.

18 WEST STREET — ATTLEBORO, MASSACHUSETTS, U.S.A. — Telephone Attleboro 1-0847 & 1-0848

Over 5000 Items Listed in New 1950 Tri-State Electrical Catalog

OVER 5000 items and sizes of electric supply and equipment, including wires, insulations, varnishes, sealers, enamels, brushes, bearings, commutators and tools, are now included in the new 1950, 68-page catalog of **Tri-State Supply Corporations**, according to **C. F. Bowers,** President.

★ ★ ★

ITEMS listed in the catalog, represent the top lines of over 19 of the nation's leading manufacturers such as Anaconda, Bunting, Du Pont, Dow-Corning, Minnesota Mining and Taylor, as well as others of equal importance. Emphasis of cataloging has been placed on those items which have been found to be most in demand for Western manufacturing and maintenance of electrical equipment.

★ ★ ★

A. H. ("ART") HOWARD, Vice President of Tri-State, was recently elected 1st Vice President of the Electric Club of Los Angeles.

★ ★ ★

A. H. Howard, Vice-Pres., Tri-States Supply Corporation, Los Angeles, Calif. * * *

CATALOGS are available to readers of this publication by writing Tri-State Supply Corporations, 544 S. San Pedro St., Los Angeles, California.

★ ★ ★

Riverside Metal Company Resignations

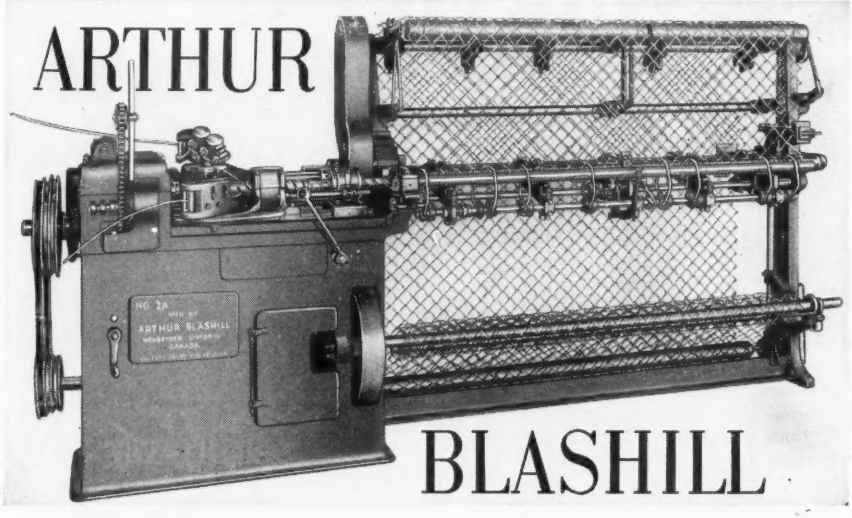
J. VINCENT HACKETT, former vice-president in charge of new business and **Lemuel N. Bruhoe,** vice-president and works manager, have both recently resigned their posts in the **Riverside Metal Company,** Riverside, N. J.

★ ★ ★

Herbert D. Rollo

IT is with deep regret we announce that Mr. Herbert D. Rollo, New England District Sales Manager for the Wickwire Spencer Steel Division of The Colorado Fuel and Iron Corporation, died on October 8, 1949.

★ ★ ★



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ULTIMATE
in
Spiral Forming, or
Weaving Speed.
and
Fast Automatic Cut-off,
advance and finishing
edges.

NO. 2A CHAIN-LINK MACHINES

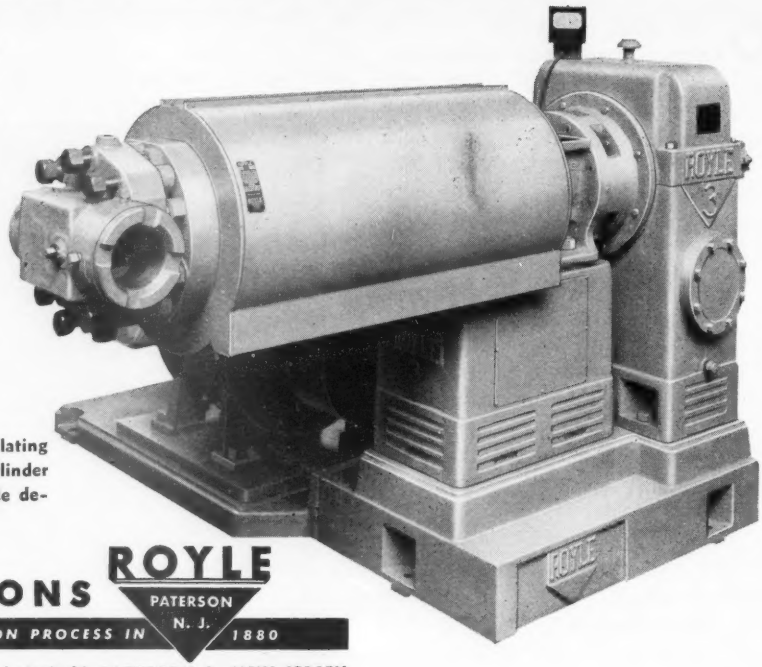
TAKE—Minimum Floor Space Power and Maintenance

PRODUCE—More Fence with Less Labor

WOODSTOCK, ONTARIO, CANADA (Formerly at Birmingham, England)

ROYLE *for WIRE INSULATING*

- Continuous Vulcanizing Machines for Rubber Wire Insulation
- Plastic Wire Insulation Machines
- Strainers • Cooling Troughs
- Light Wire & Cable Capstans
- Motorized Take-Ups
- Temperature Control Units for Extrusion Processes and other industrial uses



ROYLE # 3 Plastic Wire Insulating Machine. Double extended cylinder enclosed in insulating jacket, side delivery head.

JOHN ROYLE & SONS ROYLE PATERSON N. J.

PIONEERED THE CONTINUOUS EXTRUSION PROCESS IN 1880

London, England — James Day (Machinery) Ltd. — REgent 2430
Home Office — J. W. VanRiper — SHerwood 2-8262
Akron, Ohio — J. C. Clinefelter — JEfferson 3264
Los Angeles, Cal. — H. M. Royal, Inc. — LOgan 3261

PATERSON 3, NEW JERSEY

The *SPECIALISTS* in Wire-Straightening and Wire-Cutting!

Diameter Range — 1/16" to .005"

PRECISION - Our Motto

DON'T hesitate to call on us when you are confronted with wire-straightening problems involving close tolerances and absolute accuracy. For seventeen years we have specialized in straightening and cutting all gauges of fine wire, hard or soft, ranging in diameter from one-sixteenth of an inch down to five-thousandths of an inch. We employ gun-barrel accuracy in straightening lengths from one inch to ten feet or any fractional part thereof. Ends cut absolutely clean without burrs.

•

ASK ABOUT OUR UNEXCELLED FACILITIES FOR CLEANING AND POINTING WIRE ALREADY STRAIGHTENED AND CUT.

ALL TYPES OF WIRE...

- Nickel
- Stainless Steel
- Bronze
- Brass
- Copper
- Alloy Wire
- Music Wire
- Tag Wire
- Florist Wire

Write us today!

Manufacturers of the famous ARMA PAPER CLIP

PITTSBURGH CUT WIRE COMPANY

1112-20 GALVESTON AVENUE • PITTSBURGH, PENNSYLVANIA.

TELEPHONE: CEdar 4702

A Review of Recent Wire Patents

NO. 2,486,450 WIRE FORMING MACHINE, patented November 1, 1949 by Albert S. Wahl, Jersey City, N. J., assignor to Solo Products Corporation, New York, N. Y., a corporation of New York.

This is described embodying a machine faster in operation than the "slide type" of automatic wire forming machine and will take wire of various transverse cross sections.

★ ★ ★

NO. 2,486,664, RUSTPROOF COATING OF FERROUS METALS, patented November 1, 1949 by Paul E. Marling and John E. Malowan, Dayton, Ohio, assignors to Monsanto Chemical Company, St. Louis, Mo., a corporation of Delaware.

The coating comprises a film-forming drying oil, an alkyd resin soluble therein and, as a pigment, finely divided red phosphorus dispersed therein, the red phosphorus being devoid of yellow phosphorus and oxygen compounds of phosphorus.

★ ★ ★

NO. 2,486,665, COATING COMPOSITION COMPRISING AN ALKYD RESIN AND AN ALKOXY METHYLOLMELAMINE, patented November 1, 1949 by Paul E. Marling, Dayton, Ohio, assignor to Monsanto Chemical Company, St. Louis, Mo., a corporation of Delaware.

In the process, the inventor proceeds by forming an alkyd resin by heating in the presence of anthraquinone a mixture of mono- and diglycerides of drying oil acids with an organic polybasic carboxylic acid to form an alkyd resin and then blending the alkyd resin with an alkyd ether of methylolmelamine soluble in butanol, this blending being carried out in the proportions, based on solids content of from 15% to 50% of the alkyd ether of methylolmelamine to from 85% to 50% of the alkyd resin.

★ ★ ★

NO. 2,487,137, PRODUCING COATINGS ON METAL, patented November 8, 1949 by George R. Hoover and Norman Cox, Middletown, Ohio, assignors to Armco Steel Corporation, a corporation of Ohio.

In producing the coatings on iron, steel and aluminum surfaces articles having such surfaces are immersed in a solution consisting of an oxidizing agent adapted to remove hydrogen in the process and equivalent to .30% to 2.65% nitrate, flourine, and an acid phosphate of a metal which will deposit as a phosphate coating, water being the solvent, this solution having a ratio of free acid to total acid of 1:2 to 1:10, a free acid content from substantially 1.5 to 10 points, a total acid content from 16.0 to 65 points, and in which the fluorine in the solution results from the addition of a material from either hydrofluoric acid or its salts, the amount of fluorine present being substantially 0.015% to 0.80% by weight, maintaining the solution at temperatures between 120° and 210°F., and withdrawing the articles from the solution after a treatment time of 5 seconds to 1 minute.

Complete Description and Drawings of Patents May Be Had for 50 cents, outside the United States and Canada $1.00. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

★ ★ ★

NO. 2,488,039 WIRE-FEEDING AND RETRACTING APPARATUS, patented November 15, 1949 by Harry J. Sketchley, Los Angeles, Calif.

The apparatus is adapted to pay out and rotate the wire.

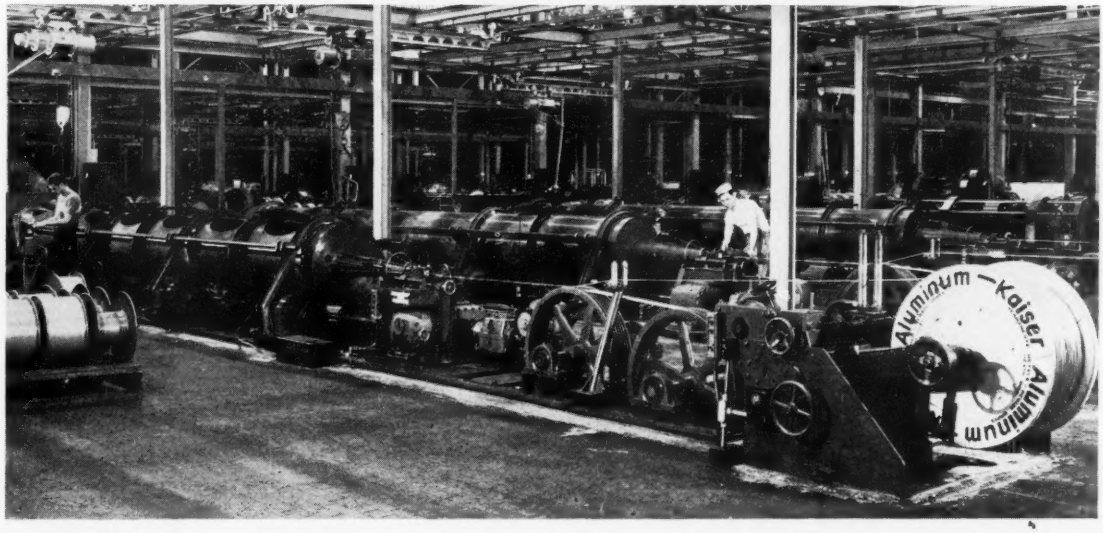
★ ★ ★

NO. 2,488,211, HIGH-FREQUENCY CABLE, patented November 15, 1949 by Cecil George Lemon, London, England, assignor to Tenaplas Limited, London, England, a British company.

About the wire conductor is a screen which carries means insulatedly sup-

NEW 22" SPOOL 750 RPM TUBULAR STRANDER

HYDRAULIC LIFT REEL STAND—INFINITELY VARIABLE TRAVERSE AIR CONTROLLED
DOUBLE DRUM HAUL-OFF WITH LINK BELT P.I.V.—AIR OPERATED BRAKING SYSTEM



HMT
ESTABLISHED 1846
HUGHESVILLE MACHINE & TOOL COMPANY
WIRE & PROCESS MACHINERY

Hi-Efficiency

HUGHESVILLE MACHINE & TOOL CO.
54 ACADEMY STREET
HUGHESVILLE, PA.
Phone: 129-A

porting the wire and comprises open-mesh insulating braiding and longitudinally continuous insulating sheathing.

★ ★ ★

NO. 2,488,277, MAGNETIC WIRE FOOTAGE METER, patented November 15, 1949 by Charles J. Falk, Richard K. Fairley, and Thomas T. Short, Schenectady, N. Y., assignors to General Electric Company, a corporation of New York.

This meter is adapted to measure the length of magnetic wire travelling past the meter after it has been impressed with a magnetic mark by a marking head.

★ ★ ★

REISSUE 23,169, WIRE BENDING MACHINE, patented November 22, 1949 by Frank J. Horton, Decker, Mich., assignor to No Sag Spring Company, Detroit, Mich., a corporation of Michigan.

The machine is equipped for dividing sinuously formed wire into sections and bending the ends.

★ ★ ★

NO. 2,488,578, INSULATION TESTING DEVICE, patented November 22, 1949 by Wentworth D. Boynton, Clay E. Lewis, and George R. Page, Baltimore, Md., assignors to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

For testing supported insulated wire conductors, the inventors provide a number of flexible electroconductive chains of different lengths supported from only one of the ends thereof and over the wire with the longer chains at the sides of the axis of the wire and the shorter chains approximately over that axis.

★ ★ ★

NO. 2,489,108, REEL FOR WIRE-WINDING MACHINES AND THE LIKE, patented November 22, 1949 by Paul A. Schmidt, Earlville, Ill.

This reel comprises a pair of flat end members in parallel spaced relationship adapted to be rotatably supported on an axis extending centrally through the members, and inwardly extending spaced rods carried by the members and sloping inward toward the axis with the inner ends of the respective rods overlapping between the members.

★ ★ ★

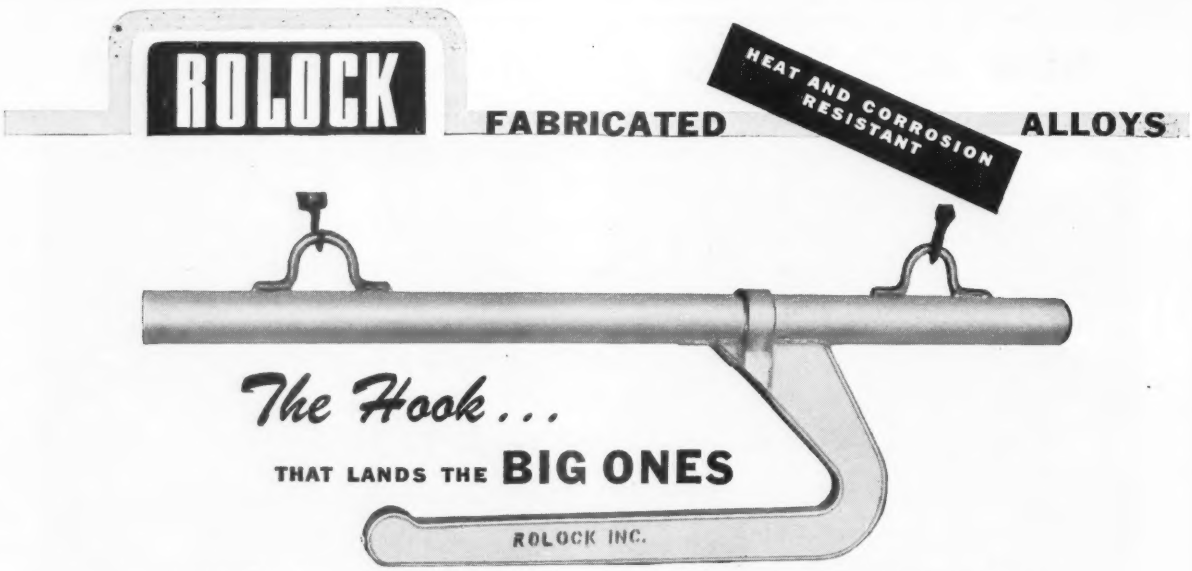
NO. 2,489,921, WIRE STRAIGHTENER AND CUTTER, patented November 29, 1949 by John H. Moore, Roscommon, Mich., assignor to Carl W. Richter, Rochester, Mich.

Adjacent the reciprocating shear blade of the machine is a wire-supporting plate which is spaced axially of the wire from a cut-off bushing and the shear blade. The wire receiving plate is moved from one to another of wire-receiving positions.

★ ★ ★

Hubbard Introduces Cost-Cutting Plastic Spools for Wire

AT long last a practical plastic spool for the wire industry has arrived according to announcement made by **Hubbard Spool Company**, of Chicago. Plastic spools, long predicted by plastics engineers as the next step in spool progress, have been previously delayed by the difficulties of finding a plastic material that possessed the particular characteristics needed for wire storage and shipping. A new type filler, combined with a special thermosetting resin has been discovered by Hubbard engineers to have all the desirable properties hoped for in a plastic spool. Impact resistance is notably higher than with any previous "high impact" thermosetting molding material. At a recent demonstration of the new spool, a Hubbard engineer struck the spool a series of heavy blows with a ball peen hammer without fracturing or chipping the spool. This was



BIG ORDERS, we mean . . . and why not! Here's the last word for wire coil handling. It's rugged. Handles 4000 lb. load of coils. It's much safer to use. Fabricated—welded in Steel for rod baking, Monel for pickling steel, Stainless Steel for pickling brass.

This one (of an order of 10) is 7'6" long; hook 3'8½"; throat 16", but can be made to suit your load and existing tank. Cuts hourly costs, gives long service life, handles easily and safely. Reorders indicate high satisfaction. May we quote?

ROLOCK INC. 1312 Kings Highway, Fairfield, Conn.

Offices in: PHILADELPHIA • CLEVELAND • DETROIT • HOUSTON • INDIANAPOLIS • CHICAGO • ST. LOUIS • LOS ANGELES • MINNEAPOLIS

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

in marked contrast to a spool of "High Impact" plastic which fractured at the first blow. This unusual resistance to impact or chipping is considered a valuable asset in a wire spool, which is ordinarily subject to considerable rough handling.

★ ★ ★

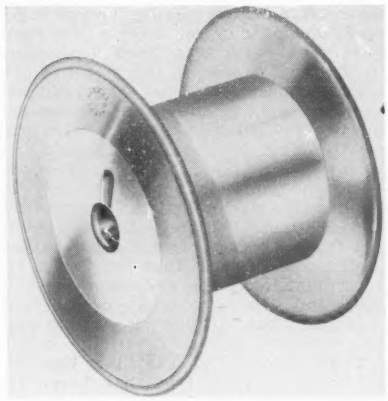
MANY other advantages are offered by this new Hubbard spool. Very important is the advantage of color. Now for the first time brand identification by color can be achieved easily by means of the color combination of the entire spool. Range of color tones is almost unlimited. As the color is integral with the plastic, it will not chip or wear off as would a painted color.

★ ★ ★

AS the plastic spools are molded in one piece, head and barrel forms a complete unit with exceptionally high rigidity to resist deflection. One-piece construction also eliminates the possibility of wire trapping. Spools are molded to very close tolerances of concentricity and run-out.

★ ★ ★

APPRECIABLE economies for the new spool are promised by the fact that first cost is lower than that of spools made of other materials, durability is greater, and shipping weight considerably less.



Hubbard's Plastic Spool for Wire. * * *

★ ★ ★

COMPLETE information can be obtained by writing Hubbard Spool Company, 1622 W. Carroll Ave., Chicago 12, Illinois.

American Steel and Wire Changes

JOHN A. SLENKER has been named manager of operations of the Duluth district of the **American Steel & Wire Company** to succeed **L. J. Westhaver** whose appointment as manager of operations of the Geneva Steel Company, another U. S. Steel subsidiary, at Geneva, Utah, was announced recently.

★ ★ ★

SUCCEEDING Mr. Slenker as general superintendent of the Duluth Works will be Clarion A. Purbaugh, formerly division superintendent, open hearth. Keith H. Moody has been appointed to succeed Mr. Purbaugh.

★ ★ ★

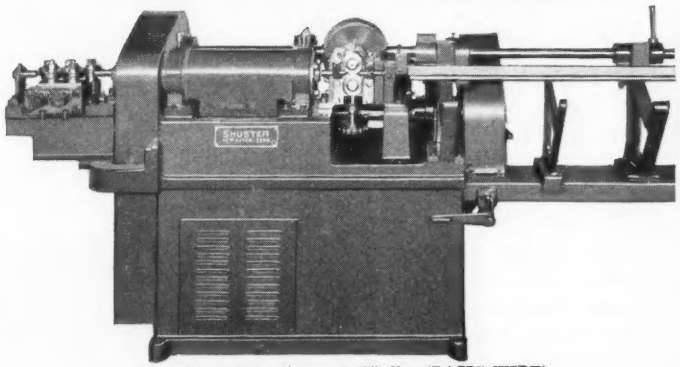
It's a New "SHUSTER!"

Model 2AB

Automatic

WIRE STRAIGHTENING AND CUTTING MACHINE

This new "SHUSTER"—with its five gear-driven straightening rolls—handles even badly twisted wire with ease. Square and rectangular as well as round wire may be straightened and cut to exact lengths. Other "Shuster" features that assure high speed, quality production are: almost continuous wire travel, rapid cut-off, V-belt motor drive, ball and roller bearings, and extreme rigidity throughout. Write for details.



Capacity: 3/16" dia. — 3/8" dia. (BASIC WIRE)

Mfd. by METTLER MACHINE TOOL, INC., 132W Lawrence St., New Haven, Conn.

SHUSTER *Automatic* Since 1866 WIRE STRAIGHTENING AND CUTTING MACHINES

Representatives in all principal cities

Wire Association Proceedings Monday, October 17th, 1949 Session

(*Continued from page 49*)

"Back Pull Wire Drawing"

rect, but from a practical operating point of view, we have operated the machine with, say, 25 per cent draft on some of the holes and 5 per cent, say, on another one, and accelerated without observing any particular change in torques or without having any trouble. So from a practical point of view the thing works.

A Member: I am not related to the speaker, so I can say anything I please about it.

I have been interested in this subject for a number of years. I have never attempted to conceal my interest. In fact, there are people in this room now who have cauliflower ears listening to me talk about it.

I started monkeying with it in 1930, at a time when business was in such a terrible state that we had nothing to do but sit at our desks and shuffle the papers over and over and wonder what was going to happen next. In 1931 I made my first deductions, which led me to believe that there was such a thing as back pull wire drawing. Professor Thompson and I were in correspondence at that time, before he apparently had stumbled on to it and we never have been able to figure out who got the idea first and it doesn't make a bit of difference anyhow.

I had been looking forward for many years to the time when the first machine, embodying these principles, was tried and I expected to be disappointed. I was, and I will tell you why.

The percentage of die pull, the percentage of power, which is due to friction between the wire and the die, differs and it differs solely with the percentage of reduction in the draft, ranging from about a third in the heavy drafts that we give ordinary low carbon basic to as high as 80 per cent in some of the very light drafts. In fact, the friction charge is a fixed charge against wire. It is a good deal like the cover charge in a high-priced restaurant. You pay the same cover charge whether you go in for an $8.00 dinner or you order a ham sandwich. The amount of friction absorbed in drawing a piece of wire in a die is almost identical at 5 per cent reduction or 45 per cent reduction. On the average 50 per cent, I find, is a pretty good country-wide average for friction loss in the die.

Now it is obvious to everyone who studied this matter that the saving made by back pull is purely and simply in the friction. There is no way to affect the amount of force that it takes to deform metal. Given a certain yield to the metal, the force acquired to deform it is fixed, but there is no law that says you have to do that deforming in the die. It is variable. The thing that can be attacked is the friction between the die and the wire, and that is going to vary directly, I was about to say, with the yield point of the metal you are drawing, but I will have to modify that and say it varies with that part of the yield point which is concerned in the die.

If you have a material with a yield point of 100,000 pounds per square inch, you require in your die to stress that metal up to 100,000 pounds per square inch in that little die cone. That is the first job the die has to do. The second one is to size and shape the wire. What we are trying to do in back pull is to divide those two functions, stress the metal before it gets to the die and leave to the die only the function of sizing and shaping.

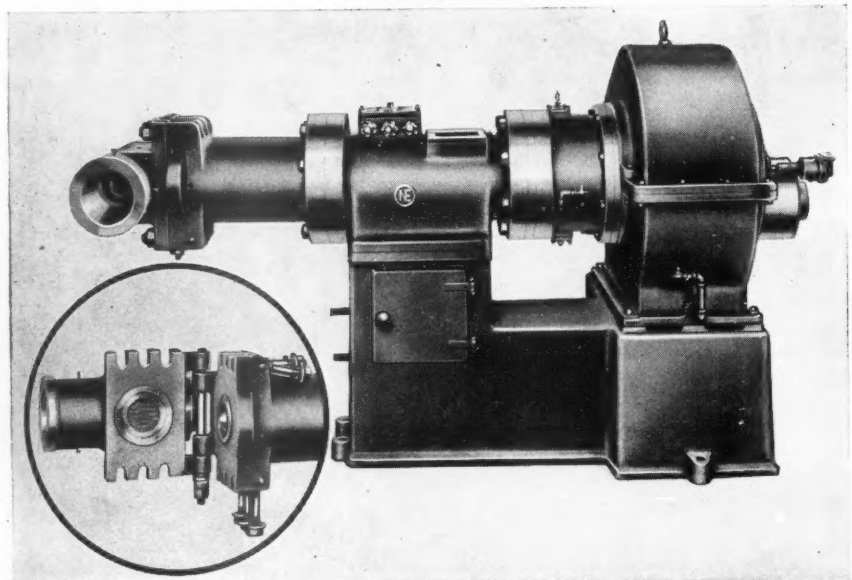
I have said that 50 per cent of the power used in drawing wire is die friction. Now that is a target, 50 per cent; and what is that of Dartrey Lewis, 7 per cent in one case and 12 per cent in the other? He has barely gotten on the target. He hasn't gotten anywhere near the first ring yet, and he is eight miles away from the bull's eye.

Now there is 50 per cent to shoot at and you are up to 7 per cent. It is disappointing, perhaps, but I have seen a lot of things in the steel industry start off worse than that. You fellows remember when James Gailey came out with his refrigerated dry air blast forty-five years ago, but it never got anywhere because refrigeration hadn't reached the proper point of efficiency. Refrigeration was coming up, and the Gailey dry air blast is going to come up again too.

In Richmond the blast by oxygen was discussed in my youth and it was tried

PLASTICS INSULATION EXTRUDER

This sturdy 4-1/2" steam heated plastic insulation wire covering machine has large capacity to permit faster operation on a wide range of wire diameters. This same machine with minor changes can be converted for rubber insulation. These machines may also be arranged for either electric contact or oil heating of the cylinder. Consult with National-Erie engineers for recommendations.



National-Erie 4-1/2" Wire Extruder designed to handle "Geon" plastic insulation.

NATIONAL-ERIE CORPORATION

ERIE, PA., U. S. A.

and it was a "flop." It has just been waiting for cheaper oxygen and is coming up again. Everybody here probably remembers the first carbide dies; maybe not as far back as I saw them, because I was in pretty early. They were the most porous, unreliable and generally miserable specimens of metal I ever saw. Could anybody have dreamed they would be where they are now. So I don't see anything to despair of here. A machine has been developed, a method has been set forth, experiments have been performed, the "baby is born," and I will say that I expect great things.

There are limitations. Dartrey has pointed them out. The most serious one is the quality of the steel we are drawing. It is irregular. If it was not so irregular, instead of drafting 35 and 40 and sometimes 45 per cent on a good soft basic steel, we would be drafting nearer 60. I have done a lot of drafting at 60 and 65 per cent. If you have a perfect piece of steel you can do it, but who has any perfect steel?

There is a big leeway there. You have to allow between your head pull and the actual breaking stress to permit these discontinuities, these irregularities, these flaws in our steel, to pass through the die onto the block without breaking.

Steel is a lot better now than it was when I went into the industry. Nobody will deny that. I see no reason to think that it won't get better.

In back pulls, you talk about 30 per cent. Well, when you get to 30 per cent in my experience, you are just beginning to get into the money. Twenty per cent is utterly useless. In my experience and observation such die pulls as you get out of these cascade wire drawing machines for wet work have no significance whatever. In 30 per cent you are just beginning to creep into the money. You cannot get very much above 30 per cent right now on a commercial scale, because you will break. I have worked up to 50 per cent and I worked for awhile at 60 per cent, but that was laboratory work. That wasn't work where I would take 80 per cent breaks and think I was doing pretty well. When you get up into that field, you are beginning to touch the big money.

While I am speaking of limitations, I will just mention another limitation, which is the fact that it takes maybe ten or fifteen per cent more power to start a draft than to keep it going. I was in hopes the first machine to come out would be so arranged by electrical hook-up, that it would be possible to start the machine with orthodox drafting and ease your way into a back pull, so that 10 or 15 per cent point of breakage would be out of the equation. Maybe the machine is that way. I haven't read your article carefully enough to make it out. Is that right?

Mr. Lewis: To answer that question, the machine is that way. You thread it up with a minimum of back pull, just enough to keep it tight between blocks, and the high back pull is applied after it is running at speed, by means of observing the die pressures and adjusting the torques.

A Member: You wiped that out then. I am glad to hear it.

There is another limitation and that is the weld. No matter how beautifully uniform you get wire rods in the future —I won't be here probably, but some of you fellows will see it—you still have to deal with welds, or I assume you will. Something may come up to eliminate welding. A welding is always going to be a discontinuity, or a point of weakness. Those are the limitations we have to struggle against. As far as physical properties are concerned, the work that you have done and probably the best work that can be done on a commercial scale now, on a pilot plane scale, at reasonable speeds and reasonable back pulls, is hardly adequate to get into the field where differences in physical properties are going to show up.

I was much interested in that mention of split torsions. It looks as though there might be something in that.

By way of criticism—and I suppose a man who gets up ought not to criticize a paper—I wish to say that I am sorry that you saw fit to run in that cuppy break. I don't think it has any more to do with the subject than the Emperor of China. When wire is overstressed, it will break, and if the wire has been drawn and it has weak spots, it has a transverse plane and that transverse plane has become a cup on account of the habit of wire to bulge forward when drawn. So far as I can see, all you demonstrate when you show a cuppy break, is that you show a break that was caused because it was stressed higher than it can stand. (Applause)

A Member: I am sure that many people here are better able to contribute

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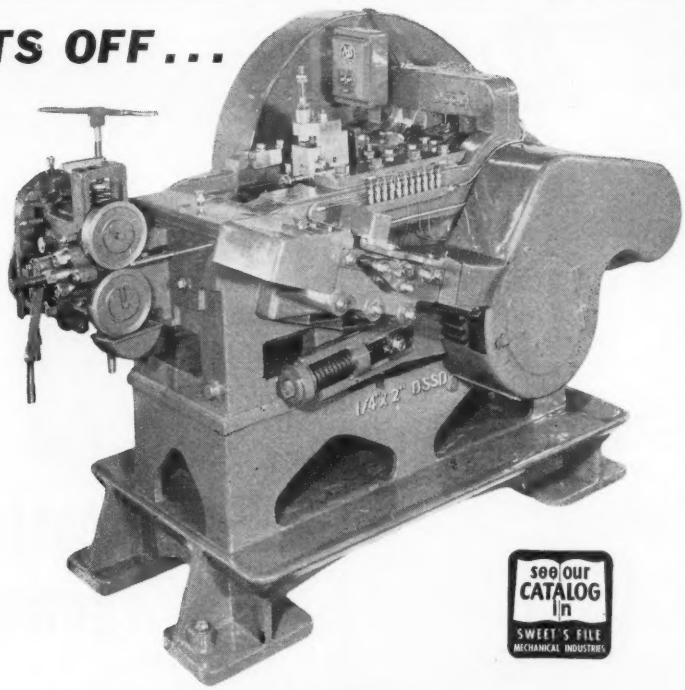

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to this discussion than I am, and I hope that we will hear from all of them before this discussion is closed.

With regard to what the member has said, I think, however, inaccurate some of his statements may be, at least none of us can fail to derive a great deal of encouragement from the tone of his remarks. I, myself, am reminded of the words of the poet, which I think most surely have been addressed to engineers in general and perhaps to wire drawing engineers in particular, which is to the effect that a little knowledge is a dangerous thing:

"Drink, thee, or taste not at this ethereal stream."

Now I, myself, do not claim a very deep knowledge on the subject of wire drawing, but I did have a very varied experience with the drawing of a large number of different materials, including both ferrous, coated and uncoated, and non-ferrous materials, and I would like you to know that I have no reason to be disappointed with the results achieved by this machine. There was no single case where we were not able to draw all of these materials at least as well as they had been drawn by established practice. In many cases we were able to draw them either with an improvement in quality or at high speeds, and that experience, I suggest, is sufficiently encouraging to decide that we pursue this development. It is also heartening to know that these things were achieved on a bunch of machines which were designed without a real knowledge of requirements. That, I think, was made sufficiently clear by the information which has been presented to us this afternoon.

We set up to design a machine, which, at that time, everyone thought was the right thing to produce very heavy, very large amounts of back pull. The fact that such machines were able successfully to draw such a large variety of materials does, I think, provide the testimonial of its versatility, and I look forward to the further development of this machine. And I would like you people, especially you people who are in the non-ferrous group, to make the kind of experiments which Mr. Lewis and his colleague have made on high carbon and low carbon steel.

I am quite sure that the machine has a future, and if any of you are interested in going further into the results obtained on non-ferrous materials, I should be very glad indeed to meet you and go into it in more detail. Thank you. (Applause)

A Member: May I make another comment? When the member started quoting from Alexander Pope, I wondered if a story could be smuggled in here appropriately.

Whenever I see back pull wire drawing attempted, I think of an incident up in New England when we were trying to dig out from under our hurricane ten or twelve years ago. Everywhere along the road there were big elm trees and oak trees down, which were being sawed up and carted away. There was one big tree and a couple of fellows were at work on it with a cross-cut saw. One of the men was a big "bruiser" of 220 pounds and the other fellow was a little shrimp, who was on the other end of the saw.

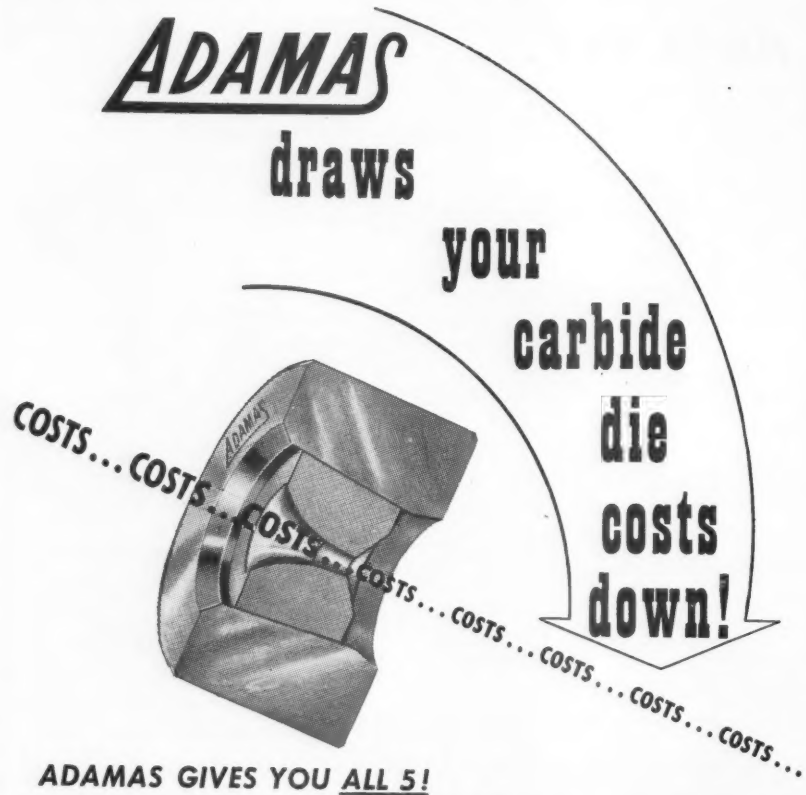
A nice old lady was driving by in a limousine. She told her chauffeur to stop the car and she jumped out and ran over to the big "bruiser" and she said, "Give the boy the saw, you big brute."

I always think of that when I see experiments going on on back pull. It is ridiculous, but it is really happening.

I want to toss in something out of twenty years of experience, figuring, conniving and experimenting on this matter of back pull and die pressures. I want to mention it because of something Mr. Lewis said.

Dartrey, you were speaking of Professor Thompson's experiment, stretching a wire and moving a die along with his finger, and you compared wire drawing with breaking of wire in tensile tests. Well, I did that experiment before Professor Thompson did, because I read about it somewhere else. I actually hung a wire up with a heavy weight over a pulley, a piece of copper wire, something soft, and I pushed the die along with my fingers. But what I want to say is, be careful in pondering over these matters to get your mind entirely free before you start thinking about reactions that go on in the wire and stresses in the wire and the difficulty in wire drawing, of any notions of tensile strength and breaking the wire in tension. They bear an outward similarity, but if you get them mixed up in your mind, you are going to have one awful time straightening them out again. They have very little to do with each other, very little indeed. (Applause)

A Member: Pushing the die along the wire while it is under load has been mentioned and that is giving some thought as to whether we need a die at all, and to try it out, we have constructed a machine which is now run-



ning and drawing wire without a die. In other words, it isn't drawing wire at all. It is stretching it. That machine is running at the present time. I don't think anyone needs to get excited about it. We are not going to make a continuous machine, but drawing 1 hole wire, we have come to the realization that if you put on enough stretch you don't need the die at all.

There is one thing about the Marshall Richards machine that hasn't been stressed, because it is the first machine that is drawing wire. It will cascade from block to block without any devices in between for storage time or swinging of torque arms, and because of the capability of the machine to draw wire without storage, we figure out that the wire is going through so fast that the time element that causes this low temperature and the split torsions is insufficient. There is not enough time to cause the low temperature effect. That is the biggest advancement, I think, in wire drawing practice, and I believe the important thing that the Marshall Richards machine has brought out is that it is possible to draw wire straight through without storing wire on blocks where it has time to temper or age harden due to low temperature effect.

A Member: I want to ask another question of the speaker. Dartrey, you showed us diagrams of equipment that you rigged up to measure the temperature of the wire being drawn, but you didn't mention what sort of temperature measurements you got. About how was it running?

Mr. Dartrey Lewis: You, Kenneth, were asleep during the last part of the explanation. It doesn't surprise me at all. Probably a lot of other people were asleep. I did show two slides in which the temperatures were measured by that device. The temperature of the wire coming out from the die is around 400 or 500 degrees.

The Member: I remember now. I did see it. I just want to comment that I was measuring the temperature a good many years before that by a very much simpler device, and I would like to tell about it. In the early days of wire, working with the Morgan machine, when it became evident the temperature was doing something to the quality of the wire, it became necessary to find out what that temperature was. After taking thought for a long time, I drilled a hole down into the rim of the block, and I ran the hole down until it was about at the point where the first half dozen strands of wire were coming out of the block. I filled up the hole with oil and dropped the thermometer down in the hole and got the temperature.

In those days of uncooled machines, figuring 700 feet a minute, we ran a steady 400° on low carbon wire and 470° on high carbon wire.

A Member: On that wire stretching machine, I presume you are working below the normal stretch of the wire?

A Member: No, we are utilizing the elongation.

A Member: The elongation of that wire is higher than the drafting you are using?

A Member: It is equal to the drafting.

A Member: If you were to put that wire in a testing machine, the percentage of elongation would be greater than the elongation you are giving in the pseudo-drafting?

A Member: It is equivalent to testing in the tensile machine. It is the same as a tensile test and you are drawing it to the tensile test.

A Member: What is being done is very interesting, but the product is not wire.

A Member: It is not wire. It is a cold rod, but it can be done. We have done it. We have done it on materials far removed from steel. I don't know whether any of you know about the nylon stretching or not, but nylon is reduced 50 per cent in that manner. DuPont's have a patent on it for nylon, and I saw it done in Cutter's Laboratory in Wilmington. It is remarkable what the stretching will do. We tried it before on steel before we read about it, and there is a cost saving if you are going down to small sizes; you are not necessarily using the die.

Chairman Voightlander: Are there any more comments?

If not, we will call this meeting adjourned.

. . . The meeting was adjourned at four thirty o'clock . . .

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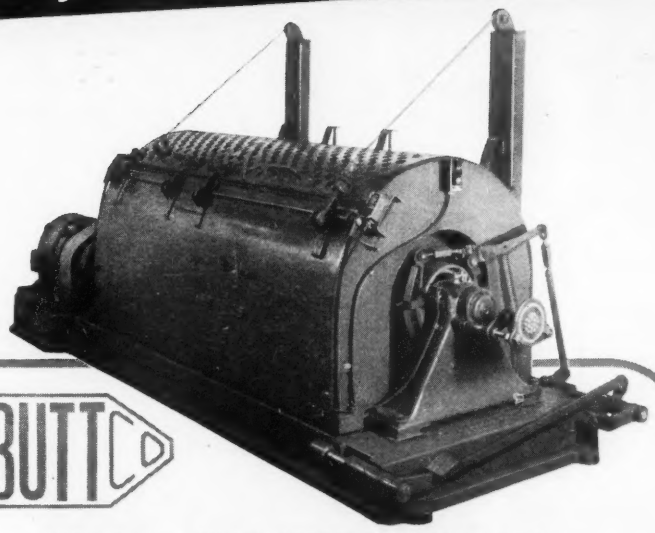

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The Symposia on Carbide and Diamond Dies held at the Convention, together with the Discussions relating to each of these sessions, will be published in the February, 1950, issue of WIRE AND WIRE PRODUCTS. This was necessary due to delays in the receipt of some manuscripts from those who had participated in the symposia.

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(*Continued from page 54*)

"Processing of Stainless Steel Wire"

ink in the pot and annealed it at good high temperature in the hope that the zinc would vaporize and diffuse into the surface of the wire and provide a coat which would act as a drawing surface that would be good, and it did. The resulting wire could be drawn very nicely, but, unfortunately, the zinc annealed along the ring boundaries and you could take that drawn wire and crumble it up in your fingers like granulated sugar.

I have often wondered whether there had been any trouble with lead left on the wire, and subsequently getting into annealing temperatures; is there any inter-granular corrosion with the use of lead?

Mr. Watkins: Very definitely. That is the reason I pointed out, I believe, that we have tests for lead removal by using dichromate solution, which we spread on the wire.

A Member: You mentioned possible pitting of the wire. I thought that was a remarkable understatement.

Mr. Watkins: We run into some trouble in continuous annealing, where the wire goes through a tube, of course, and after it some lead will possibly be carried through, because the workmen were negligent in not removing it, and it gets down in the bottom of the tube, and as the wire would dip through it, you would get areas of lead pitting that would be very severe. We did everything we could to see that all lead was removed from the wire prior to the process, because we run into trouble. Zinc is even worse than lead. Zinc will actually penetrate and embrittle stainless to a very serious degree. We know that.

Chairman Simmons: Thank you very much.

"WELDING IN THE WIRE INDUSTRY"

By John H. Corson

The next paper is by a young man, who just graduated from Lehigh University in 1943. He hasn't had much time in the steel industry, but he must be good, because in this short time he has become head of the Metallurgical Section of John A. Roebling's Sons, and that means a lot. The title of his paper is "Welding in the Wire Industry."

Mr. John H. Corson. (Applause) . . . Mr. John H. Corson presented his prepared paper on "Welding in the Wire Industry" . . . (Applause)

Chairman Simmons: I know there must be some questions following that very interesting paper.

A Member: Do you know how many high carbon welds fail per day in our mill?

Mr. Corson: It is impossible to tell how many, but we don't have too many fail. It hasn't been too great a problem with us. We do find that we have to have a welder adjusted occasionally where a welder may have a whole series of poor welds, and the welder next to it of the same make is going right along. We usually call on a maintenance man and have the welder adjusted and the man goes right along with his work again.

At most of the plants they have a man check up on the welders, and generally there is some sort of accompanying training program. In the wire drawing operation and in the ripping there are generally only a few welds which break. The paper did not emphasize the breakage at that point. The emphasis of this paper is on the physical properties of welds after the wire is drawn, and it is there that the poor qualities are present.

Chairman Simmons: Again, on the fine wire, of course, it takes a little more experience. You can't take a wire drawer that has done a lot of rough work and expect him to be experienced on specialty wire.

Mr. Corson: That is correct and exactly right. In our own rope job we have a man who examines the welder and if that is not in proper operation, he repairs it on the spot. If the man still is having trouble, he works with that man until that trouble is worked out. However, the one thing you cannot control is a man's eyesight and how he feels and whether the day is light or dark. The whole thing in the welding of the fine wire, aside from the adjusting of the machine and the teaching of the man's control over this annealing, is when men are on piece work they are going to cut it just as short as they can, although they don't realize that a few extra seconds on the annealing will make the job satisfactory. We don't deny, but we readily admit that a satisfactory annealing job can be done on the present small welders for wire welding, if the proper cautions are taken, but in our own experience we cannot depend upon that, and if one little weld can cause anywhere from half an hour to a four-hour shutdown in the rope mill, which costs money, the little extra money you might put into an extra welder or a little extra time is nothing in comparison with a three or four hour shutdown once a month, or once a week even.

Chairman Simmons: I see one of the younger members of the Micro Products Company here.

How soon are you going to put motorized heads on your micro-welders, Ben?

A Member: Another machine which we feel does what you require in the anneal and does more yet is the Model SEMT. This machine does not utilize a resistance anneal. It is rather a furnace type anneal. With this method we get away from the trouble Mr. Corson mentioned of a large burr not heating, and the rest of the wire possibly overheating. This is a furnace type anneal device reading directly in degrees on a dial. The stock is inserted in this oven, so to speak—it is really an open jaw heater strip—and it is allowed to remain there being uniformly heated throughout.

One further advantage to this setup is on the rate of cooling. We find the rate of cooling more important than the rate of heating. By allowing the very fine wire, clear down to 0048, to cool with the heater unit or oven, we are able to get away from any brittleness or any structures Mr. Corson mentioned.

Mr. Corson: Isn't that welder primarily used for copper and aluminum?

A Member: No, sir, it is not.

Mr. Corson: What is the largest steel wire that it will handle?

A Member: It will handle .040.

Mr. Corson: How long does it take?

A Member: The larger the material, the longer the time for annealing by this method, however the total weld and anneal cycle would compare favorable with your motorized device.

Mr. Simmons: Do you have many broken welds, Curt?

A Member: Yes, we have broken welds, but mostly in the rope mills. In the wire mills the broken welds are no more frequent than with most people. We have very few broken welds in wire drawing, so when Mr. Corson mentioned breaks in the wire, I wondered just where he meant. I think he has explained it since. It is in the bend of the wire after it is drawn, when you give it a bend test to see how perfect the bend is, so that you can defer a little trouble after the wire is drawn.

Mr. Corson: That is true.

A Member: But our rope mill gives us plenty of trouble. As you say, it

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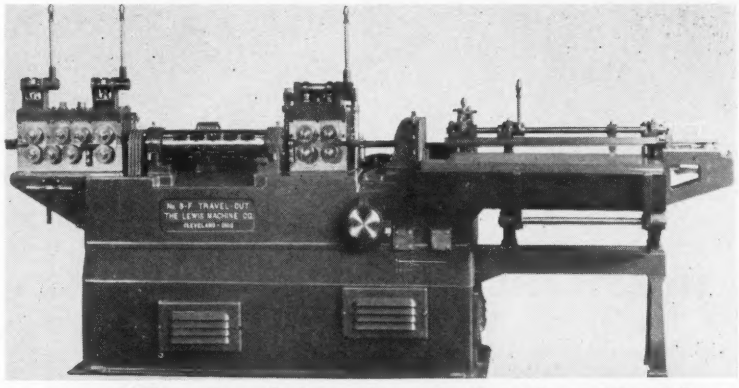

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probably is caused mostly by poor annealing or not enough annealing.

Mr. Corson: To amplify what you said from our own standpoint, we don't have any problem in making welds for wire drawing. Occasionally a man gets off the beam and makes a poor weld, or a few poor welds, or a welder might get out of adjustment, but our welders have gone through day after day. Our problem has not been along that line, but it is in the physical property after the wire is drawn. Our experience has shown they are so erratic and so poor. I think a lot of failures in your rope mills are in drawn welds which are broken, and it is time to own up to it and do something about it. We spent the last three years trying to do something about it, and we think we have the answer now, and the next job is to make a production unit and design a welder that will be a lot different from a lot of the welders you gentlemen know. We think it is going to do the job; in fact, we feel quite confident that it will. In our rope wire, as I stated to you, the welding and the annealing can be completely satisfactory; there is no question about it.

In any mill you have a few good men. You have a large number of mediocre men, or average men, and you probably have an equal or larger number of poor men, and a welder of this type penalizes the good men, but brings up the poor men. This little welder of ours has been in the mill for over a year, and we have had it with all kinds of men, and the poor man just loves it. He hates to see it taken away and given to another man, because he knows there is a lot of labor saving time saved, because he has a lot of breakdowns and you cannot get rid of them now and so you have to do something to pick him up. You lose more money from breaks of the poor men than you do with the good men. There is no doubt about it, this is a penalty on the good man, but it overcomes it so much that the controlled conditions are what we are looking for, as long as you are going to depend upon you and me doing so. Two men don't see two things alike, and in this annealing the color temperatures on a bright day and on a dark day look different, and if you have indigestion after lunch you will see another color. That is the reason that we have gone to a machine to take out the question marks that are ever present in the annealing.

A Member: We are not drawers of these wires, but we are interested in the product, and I think you did not mention the elongation with your new welds.

Mr. Corson: All right, I will tell you about elongation. I am sorry I neglected to mention it.

The elongation was just as good as the regular drawn wire, and the only thing, I am sorry so to say, is we didn't have enough welds at the time to galvanize them, so as to test them in that condition so they would meet your core wire specifications. I feel sure that had they been galvanized, they would have met those specifications without question.

A Member: I don't agree.

Mr. Corson: Good.

A Member: First off, you can get similar figures to your normal wire base in the bright wire, but then galvanized wire seems like it would be worth a little experiment. We have done it now for a year and a half. We can get good elongation on the bright wire, but after galvanizing it, it goes to pot.

Mr. Corson: You ought to have still better elongation after galvanizing.

A Member: I am sorry we don't seem to enjoy your experience.

A Member: We have had some experience with welded bars and, of course, we only have our experience in the rope shop. We purchase our wires, and, therefore, we take what we get; but we, of course, are very critical of what we are getting. While we admit that we have failures in our welding in the rope shop, made by our men on finished drawn wire, we also know that many welds that are made during the drawing of the wire do fail in our rope shop. We know it because we have definite markings, or you can see it on the wire, and it is not a failure in the wire weld made in the rope shop. We had those welds analyzed and we had the mills admit their failures made in the wire mills, or in the rod mill.

I am not a wire man, so I may not have the proper names for these different places where they are made, but the importance of a weld that breaks in the rope shop comes in when you have to make a piece of rope on the rotary drilling line, 7500 feet long, and all of a sudden one of these welds made in the rod mill or wire mill breaks and you

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have to come out in two pieces, and you have a remnant of 1200 or 1500 feet that is quite a costly affair, and, therefore, it is important to us that a wire weld or rod weld comes to us as good as it can possibly be made. But it isn't a question of it being a weld made in the rope shop or in the rod mill, those welds we make in the rope shop I think we all know when they are made and how they look when they break. They have been examined a great deal and we have been working on them for years, and I believe that a great deal of work has been accomplished by this paper that Mr. Corson presented today. I think he really deserves a great deal of credit in that direction from the rope mills.

Mr. Corson: I would like to substantiate what this member has said, because these welds in the wire mill—and I don't say that critically—have been a slipshod thing.

Let's think for a moment in terms of spot welding. If you knew the money, time and effort that goes into spot welding and took a look at a resistance butt welder, you would be ashamed of it, because these people go to all kinds of work and ends to get various controlled equipment, all this electronic timing, pressures and current timing and electrode forces and things of that sort, and here for so many years we have gone along in the same manner and everybody just talking about this subject but doing no real work upon it. That is the reason I feel in my own heart, and whatever our own influence has been in our own company, that I have tried to insist that whatever welding is done, that we do it as automatically as possible; that we take all the variables out of it, which we can take out and we make it as perfect as we can. Until that is done, the people who make ropes to sell to Mr. Hellinger are never going to have welds that you can count on. If you stand and watch as many welds tested as I have, you would have three heart attacks. You do everything that is right and the third one goes and the fourth one breaks, and it is pretty disappointing.

To come out as we have, and this work has only been accomplished two weeks ago, and that is how recent it is, it is such a pleasure to realize you have finally come upon the answer at last.

A Member: You asked why we don't do something about it. We do. We cut them out.

Mr. Corson: Good, that is pretty positive action.

A Member: I hope we have cut them all out.

Mr. Corson: It is quite obvious to notice a weld in a drawn wire. There is no doubt in anybody's mind.

A Member: I don't say we like to cut them out, but we don't care to sell wire and put them in and we don't.

A Member: No comments from the rest of us. Probably every high carbon man and rope man here appreciates the John A. Roebling's Sons Company's willingness to release such a paper as this. It costs them a lot of money and costs us nothing. (Applause)

Mr. Corson: There is one other thing that I would like to say, that this member has had trouble with broken welds in making rope and we all recognize it, but in my three years of experience in examining, very few failed ropes have come back from the field. We have never, in our personal experience, and I think that goes for Mr. Hertzhoff, who preceded me in my job, ever found a rope or rope wire which failed because it was a poor weld. These broken welds only appear, apparently, in the fabrication of that rope. You just don't want to say the welds aren't any good and throw them all out, because that is not true. We make a good bit of rope, and we have never in our own personal experience ever seen a rope which was removed because the failures were started primarily because of poor welds.

A Member: Don't get me wrong. I am not a rope man and I don't know anything about rope, but our trouble on welding comes right at the machine. I don't know what section you people are talking about here.

Mr. Corson: We run 5 rods on the top of our carbon rods through day after day without trouble, but when you talk about a round of 3/8 high carbon steel, we don't find it put through a welder without breakage of the frame. I don't know how many of you people weld that size of a cross section behind a continuous machine.

A Member: We don't attempt to weld over 5 rod and I think the other high carbon people have had trouble welding over 5 rod. Anything larger is run on single hole blocks and no welds.

Mr. Corson: We have occasion to make welds in larger sized rods. We have a machine such as Mr. Gillett's. When we

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5" and 6½" diameter ends with 1-15/16" diameter traverses.
10½" diameter ends with 3½" diameter traverses.
Traverse lengths up to 12".

J. L. CLARK MANUFACTURING CO.
600 23rd AVENUE • ROCKFORD, ILLINOIS

first started making welds in these larger size rods, we had lots of breakage too, but that wasn't due to the welding that was done, but it was due to some other internal circumstance. Once we had men on the machine who stayed there for a period of time, our trouble from welding, you might well forget about. This particular machine handles the larger sizes, starting with quarter inch up to 360 rod and the welds experienced are on 360 rod. Our next step is to go down to the smaller sizes in lower carbon content, which we automatically assume is going to be a lot easier. We have taken the toughest problems we can imagine. With the smaller contents and the lower carbon rods we should have no trouble whatsoever.

A Member: In the rope shop, after you have made a good weld, you might destroy that weld in the finishing, the removal of the flash by filing.

Mr. Corson: This is on small wire?

A Member: This is on fine wire, centering into the wire rope. You can have a good weld and the weld might be perfectly sound, but as soon as you run into flash, you run into it by nicking and scratches, you won't get a weld break, but a break in the vicinity of the weld where this finishing operation has been performed by the operator.

Mr. Corson: The only thing I can suggest there is, perhaps, the gentleman has filed so vigorously that he has reduced a cross section on either side of the weld, as you suggested, to a point where there may have been some breakage. Does that answer your point?

A Member: To a degree, yes, but my point is this, regardless of how good a weld you make, until the method of removing that flash from the operators end, you still have wire breakage. The operation is at fault.

Mr. Corson: I don't quite agree with you from this standpoint only, that is this, that the size of that flash can be controlled. You can make an upset so small that you can forget about it. With this machine, this little welder we have had it so closely controlled and the tolerances have been so close that the weld beads have been almost negligible, and still we have had a satisfactory weld.

A lot of people, I think—I am just saying this from picking it out of my mind; perhaps it is a figment of my imagination—think large flashes are necessary, that they show up a lot better, but that is not true at all. You can get weld beads as small as you can get away with and still have a weld with good fusion, and your filing becomes a minor problem. You should not run into this business of over filing some section of the wire adjacent to the weld.

Chairman Simmons: Mr. Corson, we all thank you and thank John A. Roebling's Sons Company and everybody for your very interesting and very valuable paper. (Applause)

. . . The meeting was adjourned at twelve thirty o'clock . . .

STANNOUS SULPHATE

for IMPROVED LIQUOR FINISHING of STEEL WIRE!

Stannous Sulphate, used for either straw color or white liquor finishing, provides these outstanding advantages:

1. A superior, smoother coating
2. Positive control — making it possible to produce uniform coatings day in and day out
3. Easier to use — fewer operations involved
4. Economy — requires use of less copper sulphate, less acid
5. More Economy — reduces tin losses by eliminating high tin sludging.

Write for information on how to use Stannous Sulphate to best advantage in your liquor finishing.

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Rodine®
Selective Inhibitors

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- *Saves both acid and metal, cuts pickling costs.*
- *Promotes scale removal.*
- *Prolongs the life of the pickle bath.*
- *Prevents over-pickling.*
- *Minimizes hydrogen embrittlement.*
- *Improves pickling . . . gives a brighter, cleaner, smoother surface.*
- *Reduces acid fumes.*
- *Improves working conditions.*
- *Permits close control of pickling operations.*
- *Boosts pickling production.*

Send for further information about RODINE and how it can help your own pickling production.

American Chemical Paint Co.
AMBLER ACP PENNA.

Friday, October 21, 1949
Morning Session

(*Continued from page 56*)

"Magnet Wire Plant—Ft. Wayne Wks. General Electric Co."

them, which would tend to block off the floor, if you ask the annealers. It is obviously to get the slopes in the right direction, so that you don't have accumulations blocking over the low points. I know of no troubles in that respect whatsoever.

In regard to drawing speeds, we break down at either 2300 or 3100 feet a minute, depending on the size of the rod going into the mills, and we watch that our entering speed doesn't get too high and become a hazard. This rod would be 081 or 114. We enter that into our end machines or C drawing machines for end range wire. They have a surface speed of 4000 feet a minute. The older one is 3500, and the B drawing machines' surface speed is 5000 feet a minute, and we are running our A's about 4500 feet a minute. Does that answer your question?

A Member: Yes, thank you very much.

A Member: That brought up another question in my mind. What size rod are you using?

Mr. Arnold: We are entering into the F machines, 5.6 rods, and the D machines a one quarter inch rod.

A Member: What size rod do you shave?

Mr. Arnold: Largely a 7.6 rod.

A Member: I would like to ask, in regard to shaving, has it been determined what is the very minimum thickness that is required to shave? Or let me put it this way, if you had a process, which you didn't have to chip groove, or use the chip grooving method on, and just had to take off the minimum required to get under the surface defects, roughly what would be the minimum thickness of removal?

Mr. Arnold: I don't know that I can answer it exactly, as you stated it. I can tell you what we do. Of course, we have a chip breaker score put on the rod. We take off, or we talk about taking off 12 thousandths, six on a side. We are actually taking off 5 on a side. Our experience, I don't believe, is parallel to everyone. I understand some people take off a little more than that. That might not be the answer you wanted. You asked what the minimum might be and I can't answer that.

A Member: Is that minimum determined by the grooving?

Mr. Arnold: It is determined mostly by what we find necessary to get us entirely under the scale. That is about what determines it. It is a lot like a cutting tool, when you want to get under it and not just into it or through it.

Chairman Boyd: Are there any more questions, gentlemen, or comments?

Thank you very much, Dick. That was a very fine paper.

If there is nothing more, we will adjourn.

. . . The meeting was adjourned at twelve o'clock . . .

Yarns for Electric Wire

Proven by wide usage — greater efficiency in Serving and Braiding when packages of Silk, Nylon or Acetate are the product of our mills.

Producers also of Tracer and Marker Trams that meet Underwriters' Laboratory Specifications.

Consult us on your specific problems.

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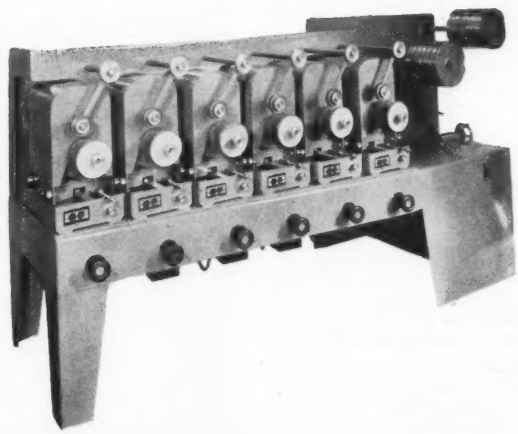
Industrial Yarn Division 119 West 40th St., New York 18, N.Y.



Horizontal Multiple Wire Pull-Out No. 886

Each spool unit traverses independently and is driven by a separate torque motor capstan driven by separate motor through speed variator • welded steel frame and ball-bearing mounted throughout. Ideal for ribbon wire.

Other models available

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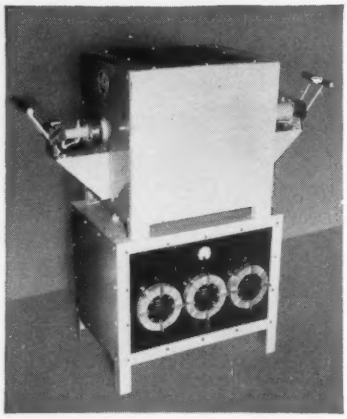

Harper Tube Furnace Model GT-20 HM-30

Harper

HIGH TEMPERATURE
Electric
TUBE FURNACES

For General Research

Temperatures to 3000 F

Research laboratories have a need for a small high temperature atmosphere test furnace for research on new products and new methods. The above furnace provides economical equipment for the intermittent testing of small samples. Materials can be heated to maximum temperatures and cooled quickly, enabling tests to be made during a working day with a saving in laboratory time. Power requirements are low and when working with special atmospheres gas lines can be turned off when firing is completed.

Uses of this furnace include: Sintering, Brazing, Heat Treating, Bright Annealing, Testing in Special Atmospheres, and General Research.

The above furnace is available in several sizes. Harper Engineers will be glad to work out special features to meet individual heat treating needs.

Write for Bulletin No. 1148.

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ELECTRIC FURNACE
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1444 Buffalo Avenue, Niagara Falls, N. Y.
Representatives in all principal cities.

E. D. Bent Made Chief Engineer of Northern Electric

E. D. BENT, former assistant chief engineer of the wire and cable division, **Northern Electric Company, Limited,** has been appointed chief engineer, succeeding the late **N. L. Dann.** Born in Bridgetown, Nova Scotia, Mr. Bent was graduated from Acadia University with a B.Sc. degree in 1928. He joined the company's wire and cable laboratory in September, 1929, was put in charge of the wire and cable laboratories in 1941 and made design and development engineer in 1947. In January, of last year, Mr. Bent was appointed assistant chief engineer and his appointment to chief engineer was made effective on November 1, 1949.

★ ★ ★

MR. Bent is a member of several outstanding business institutes and societies. He is an associate member of the American Institute of Electrical Engineers, and is currently a member of the A.I.E.E. committee on insulated conductors, a member of the Corporation of Professional Engineers of Quebec, the Chemical Institute of Canada, and served as chairman of the Quebec Rubber and Plastics Group from 1945 through 1946. He is also a member of the National Association of Corrosion Engineers and is on a committee on corrosion test methods, sub-committee on rural conductors of C.E.-A. He is also a member of the Canadian Government Purchasing Standards.

★ ★ ★

Louis P. Miller

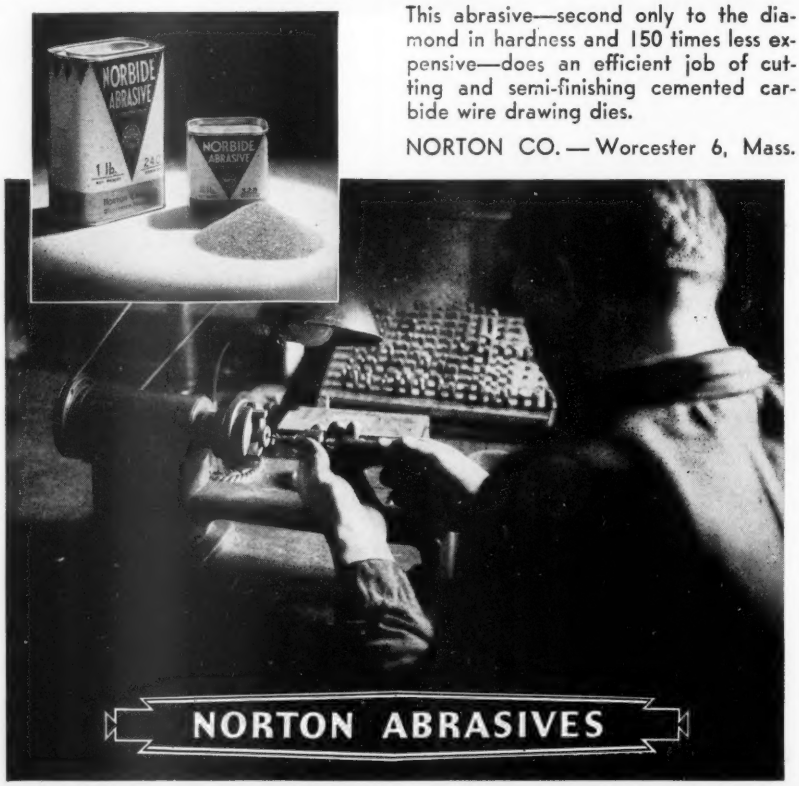
LOUIS P. MILLER, eighty-four, retired superintendent of the **Gilbert and Bennett Manufacturing Company,** makers of wire products in Georgetown, Conn., died on December 3rd at the Norwalk Hospital. He was the son of David H. Miller, president of the Gilbert and Bennett Company from 1906 to 1915.

★ ★ ★

NORBIDE Abrasive: Effective, Economical

This abrasive—second only to the diamond in hardness and 150 times less expensive—does an efficient job of cutting and semi-finishing cemented carbide wire drawing dies.

NORTON CO. — Worcester 6, Mass.



Carbide Heading Hammers with Markings Announced by Carboloy Company, Inc.

COMBINATION bolt heading and marking hammers of solid carbide for automatic bolt heading machines are now available from **Carboloy Company, Inc.**, Detroit. The new hammers make it possible to eliminate the separate marking operation frequently performed in the manufacture of bolts, rivets, etc. Simultaneously with the heading operation, manufacturers thus can:

1. **Mark bolts, screws, and rivets to indicate size or analysis of metal, or both, during the heading operation.**
2. **Take advantage of the extreme hardness and wear resistance of tungsten carbide to assure clean markings over long runs.**

★ ★ ★

THE new combination heading hammers are offered in addition to the plain solid carbide types offered by Carboloy. Use of such solid hammers are reported to have demonstrated consistent ability to increase production, reduce downtime and decrease bolt-heading hammer maintenance.

★ ★ ★

AS an indication of the ability of carbide metals to stand up in such service, some of the new combination carbide marking and heading hammers have already produced, to date, as many as 900,000 cap screws in production runs —without showing any discernible signs of wear on the markings. Steel dies on the same job are reported to have worn out after heading and marking only 1/10th that number. When the markings eventually do become worn, the carbide hammers can be re-ground, of course, for use in plain heading operations.

★ ★ ☆

New Scovill Strip Mill Placed in Operation

IN December the **Scovill Manufacturing Company**, Waterbury, Conn., started up their new $10,000,000 continuous strip mill, capable of producing the heaviest cold-rolled, non-welded brass coils in the industry.

★ ★ ★

Machinery for

SPOOLING AND COILING WIRE

We have helped improve efficiency of many companies through use of our modern designs. Write us your problems and our representative will be glad to try to help you.

Recently we completed the design and construction of a semi-automatic coiler (the wire is fed continuously to alternating heads) for use on soft wire. Ask us about it.

●

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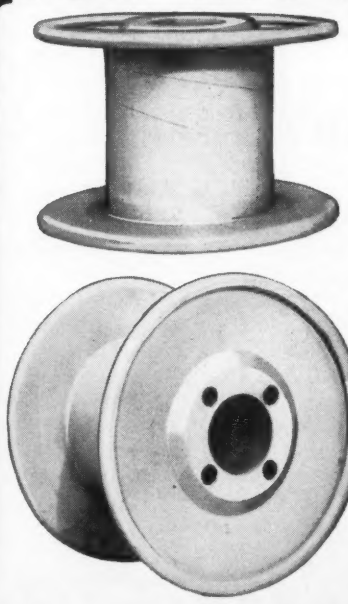
FOR HIGHEST SPEEDS



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STEEL REELS

The reels that are engineered to the job... designed and built by the company that originated the steel reel idea . . . are the reels you should be using in your plant. Every year, more and more Apco Mossberg Steel Reels are bought by quality-minded buyers throughout the wire industry.

FREE

ENGINEERING SERVICE

Without obligation to you, Apco Mossberg engineers will be glad to study your reel problem, and supply complete suggestions, drawings, blue prints. Write for information today. *Canadian Representatives:* Hugh Williams & Company, 47 Colborne St., Toronto, Ontario. *Pacific Coast Rep.*, Jack P. Williams, Jr., Matson Building, 215 Market St., San Francisco 5, Calif.

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SPECIALIZED NEEDS

I.D.I.A. MEMBER INDUSTRIAL DIAMOND ASSOCIATION OF AMERICA, INC.

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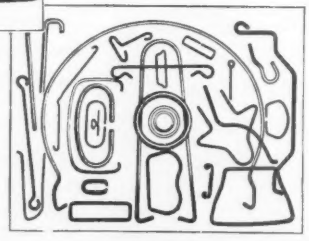
Bent on Economy?

ANY SHAPE!

ANY AMOUNT!



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See also NILSON Wire Straighteners and NILSON Stationary and Tilting Wire Reels.

Write for pamphlet "W."

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The A. H. NILSON MACHINE CO.
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Automatic Wire and Metal Forming Machines • Staple Forming Machines • Chain Making Machinery • Foot and Power Presses • Wire Reels • Wire Straighteners.

SPECIALISTS IN WIRE FORMING EQUIPMENT FOR OVER 50 YEARS

IT capitalizes on the development by Scovill of a unique continuous brass-casting process that required the building of special equipment geared to the capacity of the casting mechanisms.

★ ★ ★

IT brings to one of America's oldest brass mills the newest and most efficient of strip manufacturing equipment. Metal to be cast is melted in three induction heated furnaces, each with a capacity of 10,000 pounds per hour.

★ ★ ★

AT staggered intervals each of the furnaces discharge into a holding furnace of 9,000 pounds capacity. This furnace, mounted over the casting machine, provides a continuous flow of molten brass of uniform quality in the form of flat brass for cold rolling. Bars weigh over 2000 pounds each. Equipment for this was designed and built by the **Electric Furnace Company** of Salem, Ohio.

★ ★ ★

SOME of the other suppliers were: melting furnaces, **Ajax Engineering Co.:** equipment to process brass strip and sheet, **Waterbury-Farrel Foundry & Machine Co.:** annealing furnaces, **Surface Combustion Corporation:** and breakdown mill, **Farrell-Birmingham Company.**

★ ★ ★

Nickel

FOURDRINIER wire cloth for the paper industry made of Iconel has been given full scale plant tests that have demonstrated notable advantages over more commonly used metals.

★ ★ ★

NICKEL alloys for bolts, nuts and other parts requiring high strength and high temperature applications are finding growing favor and it is reported that increasing use of these alloys is being made in fishing equipment:—trolling lines, tackle lures and fishhooks.

★ ★ ★

Low-Carbon Stainless Steels Minimize Intergranular Corrosion

CARNEGIE-ILLINOIS STEEL CORPORATION, a United States Steel subsidiary, announces that it is prepared for commercial production of low-carbon (0.03% max.) stainless steels. These new steels, which are especially useful in industry, are made possible through mastery of the details of production and increased knowledge of the basic nature of intergranular corrosion.

★ ★ ★

UP to the present it has been necessary to add columbium or titanium to austenitic stainless steels as "stabilizers" to minimize the adverse effects of carbon and thereby render the alloy less susceptible to intergranular corrosion. The supply of these elements is sometimes critical. Consequently conservation is served by avoiding their use unless absolutely necessary.

★ ★ ★

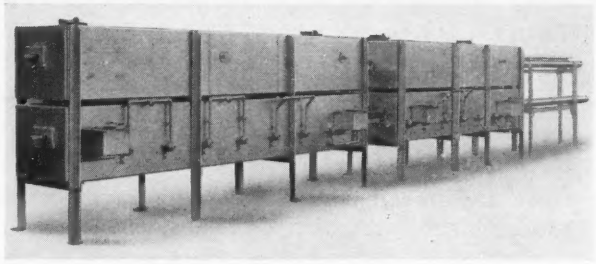
AS early as 1939, the company began investigations to determine a practical means to manufacture commercially chrome-nickel stainless steels with the lowest possible level of carbon. Concurrently with the development of manufacturing techniques, extensive corrosion-testing programs were set up in their laboratories and in those of principal customers for this type of steel.

★ ★ ★

IT has taken a decade to prove that the manufacturing techniques are economically sound and to accumulate sufficient corrosion-testing data to justify consumer acceptance of 0.03% maximum carbon stainless steels for use in many applications in which columbium or titanium stabilized stainless steels were formerly used. Moreover, the testing program has indicated that, on the basis of established standards, the 18-8 steels containing not more than 0.03% carbon have a resistance to intergranular corrosion equivalent to that of 18-8 columbium and titanium stainless steels.

ROCKWELL FURNACE-OF-THE-MONTH

Ready for Shipment to a Large Steel Wire Mill



Double-Decked Continuous Bright Hardening, Quenching and Drawing Furnaces for Strip and Flat Wire

This unique Rockwell design integrates two furnace units, one above the other, in a single compact mounting, with each pair of hardening and drawing furnaces operating independently of the other pair. The metal is heated while moving through the muffles of the hardening furnaces, thence through quench blocks, drawing furnaces and cooling tubes, always in a protective atmosphere, to emerge ready for coiling. Furnaces are gas fired, with zone control of temperature.

Rockwell builds continuous and batch furnaces, electric or fuel fired, for all wire heating operations.

ROCKWELL ALSO BUILDS — *Coil winding machines, reels and spools; pickling, brushing, cleaning, washing, finishing, drying and handling equipment; ovens and dryers; special fabrications; non-ferrous rod mills.*

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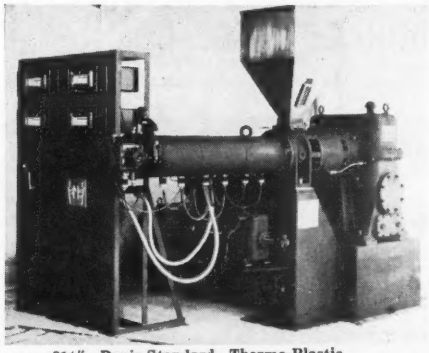
DAVIS-STANDARD Extruding Machines

Noted for ruggedness, quick warm-up, economical and high production. Complete equipment offered for rubber and thermoplastic wire insulation, continuous vulcanizing wire and cable equipment.

Complete Engineering and Manufacturing Facilities for Your Most Critical Demands.



3½" Davis-Standard Thermo-Plastic Extruding Machine

THE STANDARD MACHINERY COMPANY, MYSTIC, CONN., U.S.A.

Established in 1848
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Tinsel Conductors • *Resistance Tinsel*
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Bare electrical conductors and resistance elements wound on reels ready for insulating with plastic, rubber, etc. Available for prompt deliveries.

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We Pay Highest Prices for Used Machinery
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All Machines Reconditioned in Our Own Shop
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P. O. BOX 436, PAWTUCKET, R. I.

WELDING tests have confirmed these results and demonstrated that the low-carbon 18-8 materials can replace the stabilized types for those applications, such as welding, that involve short heating times in the sensitizing temperature range.

★ ★ ★

TEST samples of this new stainless steel have been boiled in 65 per cent nitric acid for 240 hours without corroding between the grains. Later, they were boiled 500 hours in copper sulphate and sulphuric acid—still no corrosion! The acid tests were made after the steel had been heat-treated at temperatures ranging from 1000° to 1625°F.

★ ★ ★

Oakite Holds Annual Technical-Sales Meetings

FIELD service representatives from the Canadian, Detroit, New England, New York, and Philadelphia sales divisions of **Oakite Products, Inc.,** manufacturers of specialized industrial cleaning materials, attended a series of technical-sales meetings in New York in December. Highlighting these meetings were reports delivered by the company's research chemists and service engineers on latest trends in cleaning and related procedures designed to assist industry in combating rising production costs. Also reported upon were new materials to be made available by the company during the coming year.

★ ★ ★

Similar regional conferences were held in St. Louis and Los Angeles.

★ ★ ★

"The Corrosion of Steel and Its Protective Coatings"

(*Continued from page* 37)

dipped Aluminum) coatings lost one-tenth as much **weight** as galvanized coatings under the same conditions. A two-year exposure under marine conditions showed aluminized coatings lost approximately one-fifth as much weight as galvanized coatings. At sheared edges, however, the rusting, while not serious, was noted to be great-

er than present in the case of zinc coatings.

★ ★ ★

IT is of interest that further heating of Aluminum coatings will convert the coating to Iron-Aluminide as shown in Fig. 7d. This form of aluminum coating which is similar to "Calorizing" may be heat treated to develop the desired physical properties impossible in hot-dipped Aluminum coatings. This reheating treatment, while useful in preventing scale formation at elevated temperatures—up to 1750°F.—is of little appreciable value in producing a coating to resist atmospheric or aqeous corrosion.

★ ★ ★

Conclusion

IT could be said that all metals, when exposed to the elements, have an inherent tendency to revert to one or another of the forms in which they were originally found in the earth. Even now, comparatively little has been accomplished toward solution of the corrosion problem in the general metallurgical sense, although metals resistant to corrosion have been developed for certain applications. We have attempted to show that none of these special metals is **entirely** resistant to corrosion under more than a **limited** set of conditions.

★ ★ ★

MUCH has been done in improving metallic protective coatings, but even the great advances that have been made have not brought us much nearer to that Utopian condition "where neither moth or rust doth corrupt."

★ ★ ★

LET us learn by research, but more particularly, let us learn from the present scientific knowledge of corrosion, remembering once more Benjamin Franklin's letter to his friend:

". . . and you will observe with concern how long a useful truth may be known and exist before it is generally received and practised upon."

★ ★ ★

SJOGREN TOOL AND MACHINE CO., INC.

WIRE PULLERS • WEDGE GRIPS • JAWS FOR ALL MAKES OF PULLERS AND TESTING MACHINES • CAGE ROLLERS • SWAGING HAMMERS • POINTING DIES • WIRE SPOOLERS

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SPOOLS

Standard Sizes 1¾" to 12" Head Diameters

"American" steel spools give extra strength and rigidity. Light weight saves production and shipping costs. Tough finishes include baked, enameled, plated or painted spools. Let us quote you on special designs for any purpose.

MADE TO LAST!

REELS

Standard Sizes 12" to 72" Head Diameters

For braiding, stranding, drawing, annealing, vulcanizing and shipping, "American" pressed-steel reels assure long life and cost savings. Let us quote you on standard reels or reels made to your particular specifications.

The American Pulley Company

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RUST PREVENTIVE COATINGS

You've tried the rest; why not get the best?

Being among the first to work with and develop Lanolin Protective Coatings, we know that our Coatings can definitely help, if not cure your storage or shipping rust problems.

Samples and prices on request.

AMERICAN LANOLIN CORPORATION

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Simple as A B C

Handle heavy reels easily and safely; remove wire or cable from top or bottom, front or back of reel with

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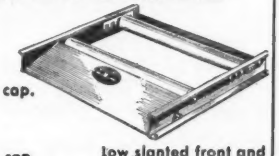

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Style B: 4,000 lbs. cap. 75.00

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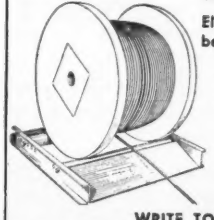
Low slanted front and positive front lock insure quick loading or unloading.

Eliminate jacks, cumbersome handling.



Carried easily to reels, job or storage.

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BORAX

More shops are turning to this most satisfactory coating material. It is easy and safe to handle. Does not create dust nuisance.

Pins of wire which have been properly washed after the acid dip, sul coated and then coated with Borax have been satisfactorily drawn after remaining in storage for several weeks.

Borax coated wire used with proper lubricant will increase die life.

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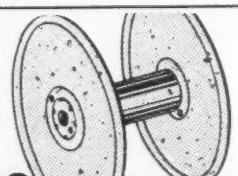

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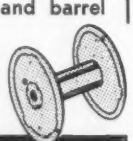

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Acknowledgment

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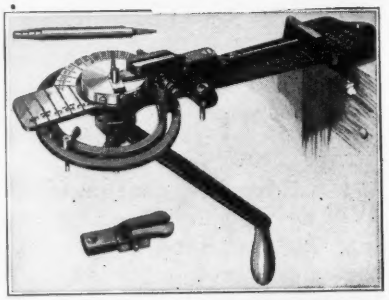

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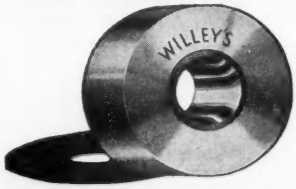

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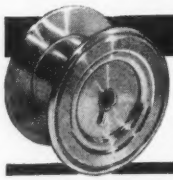

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(*Continued from page 43*)

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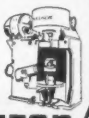
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ABRASIVES—
Norton Co., Worcester, Mass.

ACID INHIBITORS—
(See Inhibitors, Pickling)

ACID-PROOF CONSTRUCTION
Haveg Corporation, Newark, Del.
Sauereisen Cements Co., Pittsburgh, Pa.

ALUMINUM ALLOYS—
Aluminum Import Corp., New York, N. Y.

ANNEALING MACHINES—Open Flame
Syncro Machine Co., Perth Amboy, N J.

ANNEALING POTS AND BOXES—
Scudder, E. J., Foundry & Machine Co., Trenton, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machy., Inc., Pawtucket, R. I.

BAKERS—Rod and Wire
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Morgan Construction Co., Worcester, Mass.
Ross, J. O., Engr. Corp., New York, N. Y.

BAR STOCK—Stainless Steel
American Steel & Wire Company, Cleveland, Chicago, New York.
Columbia Steel Co., San Francisco, Calif
U. S. Steel Export Company, New York, N. Y.

BASKETS—Pickling
Rolock, Inc., Fairfield, Conn.

BILLETS—Aluminum for Wire
Aluminum Import Corp., New York, N. Y.

BOBBINS—Braider & Wire Weaving
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

BORAX—Wire Drawing
Pacific Coast Borax Corp., New York, N. Y.

BORON CARBIDE—
Norton Co., Worcester, Mass.

BRAKES—Pneumatic
Entwistle, Jas. L. Co., Pawtucket, R. I.

CABLE—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Import Corp., New York, N. Y.

CABLE LACQUERING OVENS—
Industrial Ovens, Inc., Cleveland, O.

CARRIERS—Braider, High Speed
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

CASTINGS—Wire Mill
Scudder, E. J., Fdry. & Mach. Co., Trenton, N.J.

CEMENTS—Acid Proof
Sauereisen Cements Co., Pittsburgh, Pa.

CEMENTS—Refractory
Norton Co., Worcester, Mass.
Sauereisen Cements Co., Pittsburgh, Pa.

CHEMICALS—Cleaning
(See Cleaners—Metal)

CLEANERS—Metal
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Phila., Pa.
Magnus Chemical Co., Garwood, N. J.
Magnuson Products Corp., Brooklyn, N. Y.
Metal & Thermit Corp., New York, N. Y.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

CLEANING & PICKLING EQUIP.—
Cleveland Tramrail Div., of the Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

CLOTH—WIRE, All Metals
Roebling's, John A. Sons, Co., Trenton, N. J.
Wickwire Bros., Cortland, N. Y.

COATING COMPOUNDS—
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

COILERS—Sheet, Strip and Wire
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J. Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Corp., Cleveland, Ohio.

COLD HEADERS—
Ajax Manufacturing Co., Cleveland, O.
Joseph Behr & Sons, Inc., Rockford, Ill.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

COMPOUNDS—Coppering
American Chemical Paint Co., Ambler, Pa.

COMPOUNDS—Diamond
Eastern Carbide Corp., New Rochelle, N. Y.
Hyprez Division, Engis Equipment Co., Chicago, Ill.
Magnus Chemical Co., Garwood, N. J.

COMPOUNDS—Metal Finishing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Metal & Thermit Corp., New York, N. Y.

COMPOUNDS—Rust Preventing
American Chemical Paint Co., Ambler, Pa.
American Lanolin Corp., Lawrence, Mass.
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.

COMPOUNDS—Rust Removing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

COMPOUNDS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Magnuson Products Corporation, Brooklyn, N. Y.
Miller, R. H. Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Pacific Coast Borax Corp., New York, N. Y.
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Inc., Chicago, Ill.
Swift & Company, Chicago, Ill.

CONDUCTORS—Flexible, Electrical
Montgomery Co., The, Windsor Locks, Conn.

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

CORDS—Electrical, Tinsel Conductor
Montgomery Co., The, Windsor Locks, Conn.

CORROSION PREVENTIVES —
Angier Corporation, The, Framingham, Mass.

CRANES—Wire Mill
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CUTTING TOOLS—Carbide
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth-Sterling Steel & Carbide Corp., McKeesport, Pa.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, New York.
Vascoloy-Ramet Corp., North Chicago, Ill.
Willey's Carbide Tool Co., Detroit, Mich.

DIAMONDS—Industrial
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Champion Diamond Co., New York, N. Y.
Diamond Distributors, Inc., New York, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND POWDERS—
Champion Diamond Co., New York, N. Y.
Diamond Distributors, Inc., New York, N. Y.
Eastern Carbide Corp., New Rochelle, N. Y.
Hyprez Division, Engis Equipment Co., Chicago, Ill.
Indiana Wire Die Co., Ft. Wayne, Ind.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND TOOLS—
Carboloy Co., Inc., Detroit, Mich.
Champion Diamond Co., New York, N. Y.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Carbide
(See Dies—Tungsten Carbide)

DIES—Cold Heading
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Vascoloy-Ramet Corp., No. Chicago, Ill.

DIES—Diamond
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Champion Diamond Co., New York, N. Y.
Cochaud Wire Die Corp., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Extrusion
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Metal Carbides Corporation, Youngstown, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Eyelet
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.

DIES—Pointing
Sjogren Tool and Machine Co., Auburn, Mass.

DIES—Repairs & Re-Cutting
Adamas, Carbide Corporation, Harrison, N. J.
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Detroit, Mich.
Champion Diamond Co., New York, N. Y.
Cochaud Wire Die Corp., New York, N. Y.
Firth-Sterling Steel & Carbide Corp., McKeesport, Pa.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Special Shapes, Etc.
Adamas, Carbide Corporation, Harrison, N. J.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth-Sterling Steel & Carbide Corp. McKeesport, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.

WHERE TO BUY, Continued

DIES—Tantalum Carbide
Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel & Carbide Corp. McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.

DIES—Tube Drawing
Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Tungsten Carbide
Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
(See MACHINERY—Draw Benches)

DRUMS—Flange Steel
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., The, Paterson, N. J.

DRYING EQUIPMENT—
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N. Y.

ENGINEERS—Consulting Hot Galvanizing
Wallace G. Imhoff Co., The, Los Angeles, Calif.

ENGINEERS—Consulting Spring Design
Carlson, Co., The, New York, N.Y.

ENGINEERS—Consulting Wire Mill
Fisher, Edward J. P., North Jackson, Ohio.
Lewis, Kenneth B., Worcester, Mass.
Wickwire, T. H. Jr., Philadelphia, Pa.

EQUIPMENT—Insulation Testing
Davis, R. L., Elec. Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FENCING & FENCES—Wire
Interlocking Fence Co., Morton, Ill.

FLUXES—Soldering
American Chemical Paint Co., Ambler, Pa.

FOAM PRODUCING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Parkin, Wm. M. Co., Pittsburgh, Pa.

FRICTION PAY-OFF STANDS—
Industrial Ovens, Inc., Cleveland, Ohio.

FURNACES—Annealing
Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Automatic
Carl-Mayer Corp., The, Cleveland, Ohio
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Brazing
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.

FURNACES—Bright Annealing
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Electric
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio.

FURNACES—Galvanizing Equipment
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Hard'ing & Temp'ing
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., The, Cleveland, Ohio.

FURNACES—Lead Melting
Electric Furnace Co., Salem, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Resistance Heating, Strand
Trauwood Engineering Co., Cleveland, Ohio.

FURNACES—Salt Bath
Electric Furnace Co., Salem, Ohio.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corporation, Toledo, O.

FURNACES—Wire, Strip & Sheet
Carl-Mayer Corp., The, Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Rockwell, W. S., Co., Fairfield, Conn.
Surface Combustion Corporation, Toledo, O.
Trauwood Engineering Co., The, Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

GALVANIZING EQUIPMENT—
Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

GRINDERS—Roll
Norton Co., The, Worcester, Mass.

HAMMERS—Swaging
Sjogren Tool and Machine Co., Auburn, Mass.

HOISTS—Electric Travelling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, Ohio.
Rolock, Inc., Fairfield, Conn.

INGOTS—Aluminum for Wire
Aluminum Import Corp., New York, N. Y.

INHIBITORS—Pickling
American Chemical Paint Co., Ambler, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

INSULATING LACQUERING SYSTEMS—Continuous
American Insulating Machine Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.

INSULATING MATERIALS—
Belding, Heminway, Corticelli Co., New York, N. Y.
Owens Corning Fiberglas Corp., Toledo, O
Standard Varnish Works, Staten Island, N. Y.
Twitchell, E. W., Philadelphia, Pa.

INSULATING MATERIALS—Paper—For Electric Wire Cable.
Merrimac Paper Co., New York, N. Y.
Twitchell, E. W., Philadelphia, Pa.

LAME—LAHN—
Montgomery Co., The, Windsor Locks, Conn.

LATHES—Die Reaming
Carboloy Co., Inc., Detroit, Mich.
Roos, Tool & Mfg. Co., Montclair, N. J.

LIME—
Warner Co., Philadelphia and Bellefonte, Pa.

LININGS—Acid and Alkali Proof
Sauereisen Cements Co., Pittsburgh, Pa.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

LUBRICANTS—Wire Drawing
(See Compounds—Wire Drawing)

LUBRICANTS—Wire Rope
Swift & Co., Chicago, Ill.

LUMBER—Wire Mill, for lagging and car blocking.
North Anson Reel Co., North Anson, Maine

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Barbed Wire
Glader Machine Works, Chicago, Ill.
Wean Engineering Co., Cleveland, Ohio.

MACHINERY—Bead Wrapping
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Braiding
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Wardwell Braiding Machine Co., Central Falls, R. I.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Brazing
Eisler Engineering Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Bunching
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Electric
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H. Machine Co., The, Bridgeport, Conn.

MACHINERY—Cable, Rope Closing
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

WHERE TO BUY, Continued

MACHINERY—Coilers
Boyd & Sons Manufacturing Co., Phila., Pa.
Eisler Engineering Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (used), New York, N. Y.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Wire & Textile Machinery, Inc., Pawtucket, R. I.

MACHINERY—Cold Heading
(See Cold Headers)

MACHINERY—Copper Wire Drawing and Rolling
Aetna-Standard Engineering Co., Youngstown, Ohio.
American Insulating Mach'y Co., Phila., Pa.
National Machinery Exchange (used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire
American Insulating Mach'y Co., Phila., Pa.
National Erie Corp., Erie, Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Syncro Machine Co., Perth Amboy, N. J.
Wardwell Braiding Machine Co., Central Falls, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cutting
Eisler Engineering Co., Newark, N. J.
Lewis Machine Co., The, Cleveland, Ohio.
Mettler Machine Tool, Inc., New Haven, Conn.
National Mach'y Exch. (Used) New York, N. Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Die Making
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Roos, Tool & Mfg. Co., Montclair, N. J.
Wayne Wire Die Co., Hillside, N. J.
Wickman, A. C., Ltd. Coventry, England.

MACHINERY—Draw Benches
Aetna-Standard Engineering Co., Youngstown, Ohio.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Edging
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Enameling
American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Extruding
National Erie Co., Erie, Pa.
Robertson, John, Co., Brooklyn, N. Y.
Royle, John, & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Fence
Blashill, Arthur, Woodstock, Ont., Canada.
Glader, Wm., Machine Works, Chicago, Ill.
Interlocking Fence Co., Morton, Ill.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Filament Coil Winding
Eisler Engineering Co., Newark, N. J.

MACHINERY—Flat Wire
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Galvanizing
(See Galvanizing Equipment)

MACHINERY—Galvanizing Wire
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

MACHINERY—Gang Winders
Entwistle, Jas. L. Co., Pawtucket, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., The, Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y Co., Phila., Pa.
National Erie Co., Erie, Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lead Encasing Presses, etc.
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Looms, Wire Weaving
Interlocking Fence Co., Morton, Ill.

MACHINERY—Magnet Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Material Handling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MACHINERY—Measuring Wire & Cable
Durant Mfg. Co., Milwaukee, Wis.
Entwistle, Jas. L. Co., Pawtucket, R.I.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works, Chicago, Ill.
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Panning
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I

MACHINERY—Pickling
Rolock, Inc., Fairfield, Conn.

MACHINERY—Pointing
Aetna-Standard Engineering Co., Youngstown, Ohio.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Poultry Wire Fencing
Interlocking Fence Co., Morton, Ill.

MACHINERY—Rod Mill
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rolling Mill
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rubber Insulating
Royle, John & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Rubber Tubing and Straining
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Screw Wire
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y Co., Phila, Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Mystic, Conn.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Spooling
American Insulating Mach'y Co., Phila., Pa.
Boyd & Sons Manufacturing Co., Phila., Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Eisler Engineering Co., Newark, N. J.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
National Mach'y Exch. (Used), New York, N.Y
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply Co., Pawtucket, R. I.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Spring Making
National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Ajax Manufacturing Co., Cleveland, O.
Lewis Machine Co., The, Cleveland, Ohio.
Mettler Machine Tool Co., New Haven, Conn.
National Mach'y Exch. (Used), New York, N.Y.
Nilson, A. H. Machine Co., Bridgeport, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Stranding
Hughesville Machine & Tool Co., Hughesville, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Forming
Wickman, A. C., Ltd., Coventry, England.

MACHINERY—Strip Steel
Aetna-Standard Engineering Co., Youngstown, Ohio.
Ruesch, H. J., Machine Co., Newark, N. J.
Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Swaging
National Erie Corp., Erie, Pa.
National Mach'y Exch. (Used), New York, N.Y
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Waterbury-Farrel Foundry & Machine Co. Waterbury, Conn.

MACHINERY—Taping
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Testing Physical
Scott Testers, Inc., Providence, R. I.

WHERE TO BUY, Continued

MACHINERY—Testing Equipment—Sparkers
Davis, R. L. Elec. Co., Wallingford, Conn.
Entwistle, Jas. L., Pawtucket, R. I.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Tinning Wire
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Wean Equipment Co., Cleveland, Ohio.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Trolley Wire
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
Marshall-Richards Machine Company, Trenton, N. J.

MACHINERY—Welding Wire
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Winding
American Insulating Mach'y Co., Phila., Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Eisler Engineering Co., Newark, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply, Pawtucket, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wind-up (Constant Tension, Variable Speed)
Aetna-Standard Engineering Co., Youngstown, Ohio.
Davis, R. L. Electric Co., Wallingford, Conn.
Industrial Ovens, Inc., Cleveland, Ohio.
Marshall-Richards Machine Company, Trenton, N. J.
Standard Machinery Co., Mystic, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Bending
Eisler Engineering Co., Newark, N. J.
Kilmer, M. D., & Co., Cleveland, Ohio.

MACHINERY—Wire Drawing
Aetna-Standard Engineering Co., Youngstown, Ohio.
American Insulating Mach'y Co., Phila., Pa.
Marshall-Richards Machine Company, Trenton, N. J.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co. Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Wire Forming
Kilmer, M. D. & Co., Cleveland, Ohio.
National Mach'y Exch. (Used), New York, N.Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Wickman, A. C., Ltd., Coventry, England.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wood Screw
National Mach'y Exch. (Used), New York, N.Y.

MACHINERY—Wrapping Straight Lengths and Tubing
Angier Corporation, The, Framingham, Mass.
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Wrapping Wire Coils
Angier Corporation, The, Framingham, Mass.
Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MILLS—Tandem, Rolling & Edging
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Co., Cleveland, Ohio.

NAILS—Wire
American Steel & Wire Co., Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling, John A. Sons Co., Trenton, N. J.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
U. S. Steel Export Co., New York, N. Y.

OVENS—Cable Lacquering
American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.

OVENS—Dehydrogenizing
Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.

OVENS—Industrial
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

OVENS—Welding Rod Coating
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

PAINTS—Heat Resisting
American Chemical Paint Co., Ambler, Pa.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Creped Wrapping
Angier Corporation, The, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.
Terkelsen Machine Co., Boston, Mass.

PAPER—For Coil Wrapping and Corrosion Prevention
Angier Corporation, The, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.
Terkelsen Machine Co., Boston, Mass.

PATENT ATTORNEYS—
Lancaster, Allwine & Rommel, Washington, D.C.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

PICKLING—Hooks, etc. Acid Resisting
Rolock, Inc., Fairfield, Conn.

PICKLING TANK LININGS—
Sauereisen Cements Co., Pittsburgh, Pa.

PLASTIC TESTERS—
Scott Testers, Inc., Providence, R. I.

PNEUMATIC CYLINDERS
Entwistle, James L. Co., Pawtucket, R. I.

POTS—Lacquer
Industrial Ovens, Inc., Cleveland, Ohio.

POTS—Lead Melting
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Robertson, John, Co., Brooklyn, N. Y.
Standard Machinery Co., Mystic, Conn.

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PULLERS AND GRIPS—For Wire
Morgan Construction Co., Worcester, Mass.
Scudder, E. J. Fdry & Mach. Co., Trenton, N.J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REEL AND TENSION STANDS—
Davis, R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Roll-a-Reel, Cincinnati, Ohio.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

REEL CRUTCHES—
Roll-a-Reel, Cincinnati, Ohio.
Watson Machine Co., Paterson, N. J.

REELS & SPOOLS—Drawn Aluminum Alloy
Acrometal Products, Inc., Minneapolis, Minn.
Hubbard Spool Co., Chicago, Ill.

REELS & SPOOLS—Annealing and Stranding
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS & SPOOLS—Collapsible
Entwistle, Jas. L. Co., Pawtucket, R. I.

REELS & SPOOLS—Plastic
Hubbard Spool Company, Chicago, Ill.

REELS & SPOOLS—Steel
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS AND SPOOLS—Shipping and Shop
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Clark, J. L., Mfg., Co., Rockford, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REELS & SPOOLS—Wooden
Acrometal Products, Inc., Minneapolis, Minn.
American Woodworking Co., Chicago, Ill.
Bridge Mfg. Co., Inc., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
North Anson Reel Co, North Anson, Maine.

REELS—Metal Bound
Durkee Mfg. Co., Pine River, Minn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Co., Chicago, Ill.
North Anson Reel Co., North Anson, Maine.

REELS—Takeoff
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Clark, J. L., Mfg. Co., Rockford, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REELS—Vulcanizing & Impregnating
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Wire Drawing
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

WHERE TO BUY, Continued

REELS—Wire Mill
Acrometal Products, Inc., Minneapolis, Minn.
American Pulley Company, Philadelphia, Pa.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REFRACTORIES—High Temperature
Norton Company, Worcester, Mass.

RESISTANCE HEATING—Annealing . Patenting, Etc.
Trauwood Engr. Co., Cleveland, Ohio.

ROD BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Rockwell, W. S., Co., Fairfield, Conn.
Ross, J. O., Engineering Corp., New York, N. Y.

RODS—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Import Corp., New York, N. Y.

RODS—Nickel Alloy
International Nickel Co., Inc., New York, N.Y.

RODS—Stainless Steel
American Steel & Wire Co., Cleveland, Ohio.

RODS—Wire—Non-Ferrous
Platt Bros. & Co., The, Waterbury, Conn.

RODS—Wire, Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

ROPE—Wire
American Steel & Wire Company, Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Roebling's John A., Sons Co., Trenton, N. J.
U. S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott Testers, Inc., Providence, R. I.

RUST PROOF COMPOUNDS—
(See Compounds—Rust Preventing)

RUST REMOVING COMPOUNDS—
(See Compounds—Rust Preventing)

SATURATION SYSTEMS—
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y Inc., Pawtucket, R. I.

SOAPS—Industrial and Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H. Co., Inc., Homer, N. Y.
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Inc., Chicago, Ill.
Swift & Company, Chicago, Ill.

SOLVENT RESIN SYSTEMS—Experimental
Industrial Ovens, Inc., Cleveland, Ohio.

STAMPINGS—Steel
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Steel
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Roebling's, John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., Paterson, N. J.

TANKS—Compound
Haveg Corp., Newark, Del.
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Haveg Corp., Newark, Del.
Sauereisen Cements Co., Pittsburgh, Pa.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.

TINSEL—Cords, Decorative
(See: Tinsel—Electric Conductor)

TINSEL—Electric Conductor
Montgomery Co., The, Windsor Locks, Conn.

TINSEL—Electric Resistance
(See: Tinsel—Electric Conductor)

TINSEL—Lame, Silver and False Gold
(See: Tinsel—Electric Conductor)

TINSEL—Thread, Silver and False Gold
(See: Tinsel—Electric Conductor)

TINSEL—Thread, Decorative
(See: Tinsel—Electric Conductor)

TINSEL—Wire
(See: Tinsel—Electric Conductor)

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

TRAVERSES—For Reels
Entwistle, James L. Co., Pawtucket, R. I.
Hubbard Spool Company, Chicago, Ill.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

TRAVERSE MECHANISMS—
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

TUBE BENDERS AND FORMERS—
H. D. Kilmer Co., Cleveland, Ohio.
Ruesch, H. J., Machine Co., Newark, N. J.

VARNISHES—For Insulation
Standard Varnish Works, Staten Island, N. Y.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Elsler Engineering Co., Newark, N. J.
Micro Products Co., Chicago Ill.

WIND-UP AND UNWIND SYSTEMS—Continuous
American Insulating Mach'y Co., Phila., Pa.
Davis R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

WIRE—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Import Corp., New York, N. Y.
Malin & Co., Cleveland, Ohio.

WIRE—Barbed
Interlocking Fence Co., Morton, Ill.

WIRE—Cast
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Cold Heading
American Steel & Wire Co., Cleveland-Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A., Sons Co., Trenton, N. J.
U. S. Steel Export Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Electric
Malin & Co., Cleveland, Ohio.

WIRE—Flat, Fine
Montgomery Co., The, Windsor Locks, Conn.

WIRE—Manufacturers
American Steel & Wire Co., Cleveland-Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
Roebling's, John A., Sons Co., Trenton, N. J.
Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Music
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Cleveland-Chicago, New York
Columbia Steel Co., San Francisco, Calif.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Malin & Co., Cleveland, Ohio.
U. S. Steel Export Co., New York, N. Y.

WIRE—Nickel & Nickel Alloy
International Nickel Co., Inc., New York, N.Y.

WIRE—Nickel Silver and Phosphor Bronze
American Brass Co., Waterbury, Conn.
Malin & Co., Cleveland, Ohio.

WIRE—Non-Ferrous to Specification for Special Purposes
American Brass Co., Waterbury, Conn.

WIRE—Spring
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Cleveland-Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Indiana.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
U.S. Steel Export Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Stainless Steel
American Steel & Wire Co., Cleveland-Chicago, New York
Columbia Steel Co., San Francisco, Calif.
Firth Sterling Steel & Carbide Co., McKeesport, Pa.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Straightening and Cutting—
Pittsburgh Cut Wire Co., Pittsburgh, Pa.
Wickwire Brothers, Inc., Cortland, N. Y.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE CLOTH—Industrial
Roebling's John A., Sons Co., Trenton, N. J.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

WRAPPING PAPER—Creped
Angier Corporation, The, Framingham, Mass.
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.

YARNS & TAPES—
Belding, Heminway, Corticelli Co., New York, N. Y.
Owens Corning Fiberglas Corp., Toledo, Ohio.
Twitchell, E. W., Philadelphia, Pa.

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

The WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON 3, NEW JERSEY, U. S. A.

WATSON

ELECTRICAL WIRE AND CABLE, WIRE ROPE AND CORDAGE MACHINERY

PLANETARY STRANDERS: Three types, many sizes, for all duties, geared or ring backturn, main rotor shaft or roller support. "Shaftless" cradles.

RIGID FRAME STRANDERS "RH." Horizontal, overhung spindle designs. Ball bearing main rotor shaft support, no support rollers.

TUBULAR STRANDERS "TH." High speed type in all sizes. Patented Boat cradles and Tungsten Carbide guide system. Rotor spool and lay head electric stops.

BUNCHERS "V." High speed, double twist, vertical designs. Minimum floor space and operating expense. Heavy duty horizontal types.

CABLERS. Planetary and high speed "HH" designs.

WATSON

CLOSERS. Planetary and high speed types for wire rope.

ARMORING MACHINES. Complete with planetary wire or metal tape heads.

JUTERS. 36 or 48 cop and to 6-inch cable passage.

SERVING HEADS. Concentric and eccentric, many designs, for threads, asbestos, etc.

TAPING HEADS. Many types and sizes. For metallic and non-metallic tapes. Eccentric, single and double-concentric. Patented uniform torque tape brake.

COMPOUND AND SATURATING TANKS. Many types and sizes.

CHALK, MICA AND OTHER POWDER APPLIERS. "Wet" and "Dry" types in a variety of designs and sizes.

CAPSTAN SECTIONS. Single tapered wheels to 10 foot dia. and double grooved types to 80 inch dia. for heaviest duty and highest haul pulls. Many sizes and designs.

LET-OFFS. Manual, mechanical, hydraulic and electric motor lift types and "Shaftless" designs to 120-inch 30-ton sizes.

GANG SPOOLERS. Table and Floor types in many sizes and designs.

REWINDERS AND COILERS. All motorized, for warehouse and shipping use.

CAPSTAN TAKEUPS. Single and in multiples.

CONTINUOUS TAKEUPS. Double reel designs, constant tension, wide speed range to cover all Continuous Vulcanizing and Plastic Extruding takeup requirements.

HEAVY DUTY TAKEUPS. "Shaftless" in many designs and sizes to 120"-50-ton. Mechanical lift, hydraulic lift, motorized lift, incline frame and other types. Line shaft, electric and hydraulic drives. Foot treadle, electric switch, pneumatic, hydraulic and mechanical controls.

TAKEUP TRANSMISSIONS. Heavy Duty, Type "D." Combines two-speed transmission, manual slack-takeup drive and multiple-disc-in-oil friction mechanism in one compact unit. Now available in three sizes.

AUTOMATIC TRAVERSES. Many sizes and arrangements. Wide lay range. Designs cover range from fine wire to 6" cable and wire rope. Fully automatic and disconnectible for manual operation. Suitable and widely used for replacement of inadequate mechanisms on older takeups.

VULCANIZERS. Cavity and Plate "Patch" units. Mechanically or pneumatically operated. Available with or without dies.

POLISHERS. Power driven, centrifugal and spring-pressure types.

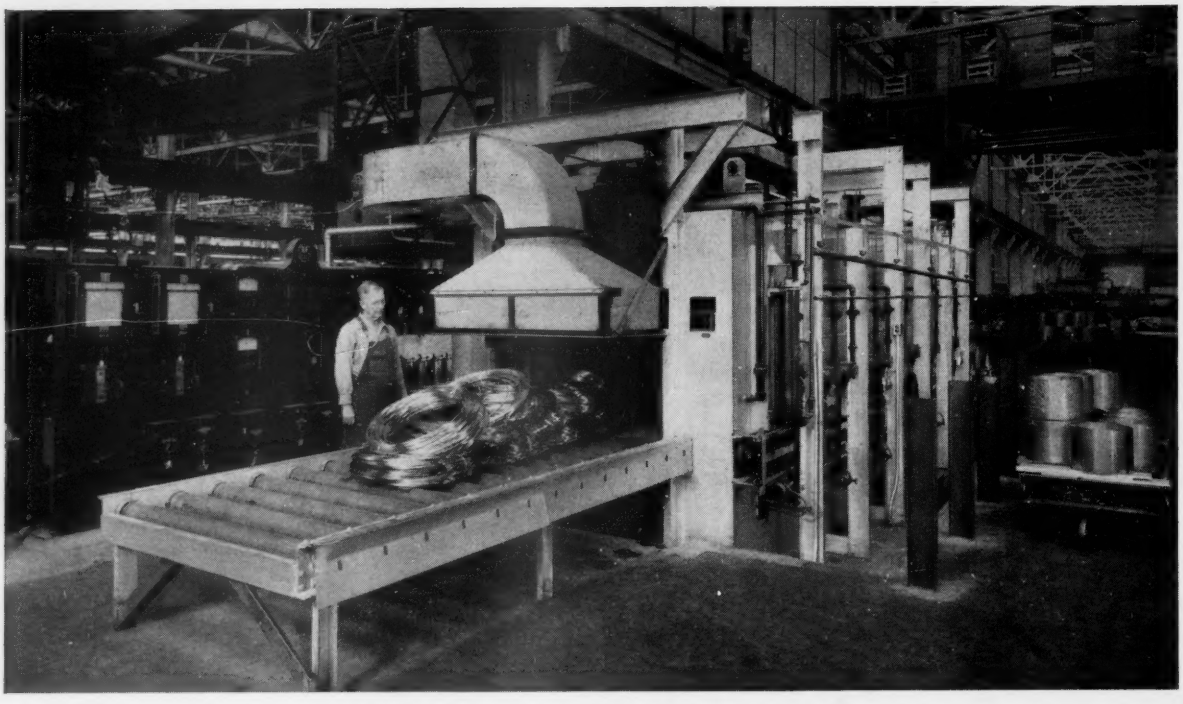
TESTING MACHINES. Impact, Torsion, Bend and Endurance types.

MEASURING MACHINES. For linear measurement. Offered in a variety of sizes and arrangements.

REEL CRUTCHES. For turning very large and heavy reels. Widely used in warehouses, shipping rooms, by railroads, steamship lines and wherever reel handling is a problem. Available from stock.

REELS AND SPOOLS. Cast Steel and Fabricated designs for extremely heavy planetary and shipping use.

CABLE PLANT AND WIRE ROPE MILL EQUIPMENT. All manners of special and miscellaneous designs for general and special purpose work too numerous for listing but on which inquiries are invited.



An EF Gas-Fired Three-Chamber Roller Hearth Furnace with Forced Circulating System Providing Accurate Temperature Distribution, Uniform Finish and Anneal—Continuously.

EF FURNACES FOR ANNEALING WIRE IN COILS, IN STRANDS ON REELS OR ON SPOOLS

High or low carbon wire, stainless steel—copper—brass—and other ferrous and nonferrous wire is being scale-free annealed, bright annealed or normalized, uniformly and continuously in EF furnaces. EF furnaces feature many service proved advantages conceived and perfected by the EF engineers and available only in EF design. These include the EF radiant tube and EF heat exchanger which combine to assure extremely high combustion efficiency; EF heavy, cast alloy electric heating elements, EF roller design and mounting, EF special atmosphere generators, and many other devices that assure uniform temperatures throughout the furnace, accurate control of heat within the required limits, low maintenance cost, high hourly output and dependable trouble-free operation.

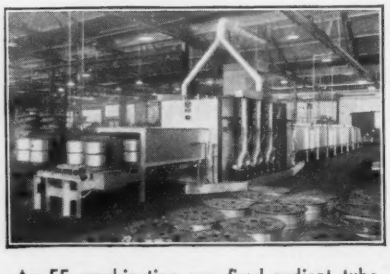
EF furnaces are built in many different types, for performing a wide variety of heating processes. Sizes to meet any production requirement. Let the EF engineers work with you on your next wire furnace problem.

EF

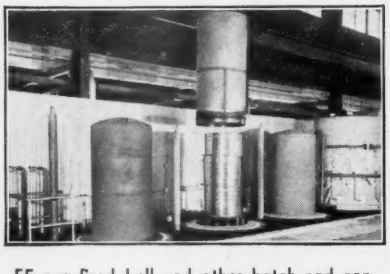
THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION

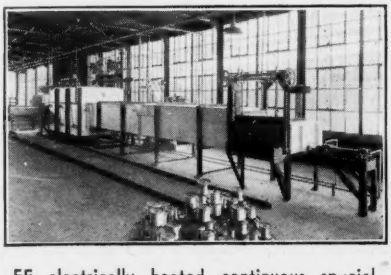
WILSON STREET *Salem - Ohio*



An EF combination gas fired radiant tube and electric furnace bright annealing 2500 pounds of copper wire per hour.



EF gas fired bell and other batch and continuous type furnaces are available for all wire treating processes.



EF electrically heated continuous special atmosphere furnace bright annealing fine copper wire on small spools.